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ORIGINAL ARTICLES.

I.—On Some Scandinavian Phyllocarida.

By Prof. T. Rupert Jones, F.R.S., and Dr. Henry Woodward, F.R.S.

(PLATE VI.)

(*Continued from page* 100.)

7. The Gastric Teeth of Ceratiocaris. Pl. VI. Figs. 8, 9, 10; and Woodcuts, Figs. 1–9.

In the Geological Magazine, Vol. II. 1865, p. 401, some account was given of the curious gastric teeth of *Ceratiocaris* and *Dithyrocaris*, from the Upper-Ludlow and Carboniferous strata of Scotland and Ireland; and in the *Article* Crustacea, by the same author, in the "Encyclopædia Britannica," vol. vi. 1877, p. 639, fig. 13, the relationship of such internal masticatory organs to the stomach of the Crab and Lobster, in particular, was treated in detail.

Bohemian specimens.—The late M. Barrande, in his "Syst. Silur. Bohême," vol. i. Supplm. 1872, p. 443, plates 18, 21, and 31, described and figured several gastric teeth, presumably of more than one species of *Ceratiocaris*, which he had obtained from his "Stage E-e 2," equivalent to the lower divisions of Murchison's "Upper Silurian." These little fossils were found in the same beds with *Ceratiocarides*,[1] but could not with certainty be referred to their species. He described them as having a general resemblance among themselves, being somewhat crescent-shaped, slightly concave on one side and convex on the other, with the middle part thicker than the ends. He does not appear to have met with any having a basal, root-like or fang-like portion attached. The number of cusps observed by M. Barrande nearly always amounted to six, the exceptions being perhaps due (he thought) to the age of individuals.

In some of the forms from Bohemia each cusp (seen from above) has the shape of a chevron, more or less distinct according to its place in the series; the strongest being in the middle, and the weakest towards the ends. Each chevron is hollow and sloping, with sharp borders. Thus, seen from above, the surface has a sharp, flexuous or zigzag ridge; each bend forming a chevron and cusp. When perfect, there is a sharp point at the top of the chevron of each cusp, and often a smaller tubercle at each of its lower ends. In his pl. 21, figs. 41, 42, and 43, the chevrons of this zigzag ridge usually open

[1] The species of Phyllocarida found in this Stage were *Ceratiocaris Bohemica*, *C. docens*, *C. inæqualis*, with *Aristozoë inclyta* and *A. Jonesi*.

towards the concave side, and their summits are towards the convex side. In fig. 44, and in others not figured, the reverse occurs; and M. Barrande could not say if the difference were of generic or only of specific value. Possibly the difference may have been due to the right or left position of the "tooth" when in place. Fig. 41 (9 mm. long) was found in the same strata with *C. inæqualis*, Barr. Fig. 42 is 8 mm. long (Woodcut, Fig. 2), and fig. 43 is imperfect; these were found in the strata with *C. Bohemica*, Barr. Fig. 44 (not quite perfect) is 14 mm. long. In pl. 18, fig. 2 (15 mm. long) differs somewhat from the others; it looks more complicated, but has been perhaps decomposed into vertical parallel layers, concentric with the chevrons. The specimen in figs. 3 and 4 (30 mm. long) is obscure. Fig. 5 (24 mm.) shows four large cusps on one (concave?) side; and six on the other, smaller, and perhaps representing the opposite ends of the chevrons. In pl. 31, fig. 21 (22 mm.) shows what appear like two nearly perfect rows of blunt cusps.

Scandinavian specimens.—The "teeth" from Fårö, Gothland, represented in our Pl. VI. Figs. 9 and 10, and Woodcuts, Figs. 1, 3, 4, belong apparently to two kinds. Figs. 10 *a*, *b*, *c*, are evidently related to those with cusps of a chevron-shape when looked at from above, and already referred to as described in M. Barrande's "Syst. Sil. Bohême." The chevrons, however, are less sharply angular in the flexuous ridges of the northern specimens (Fig. 10 *c*), and the cusps are not only less regular, but are much larger, higher, and sharper at one end of the tooth than the other (Figs. 10 *a*, *b*, *c*).

Fig. 8 (13 mm. long) shows five cusps of nearly equal size; and seen from above they appear to be united by a sharply-angular and regular zigzag ridge (Woodcuts, Figs. 1*a*, 1*b*), as in Barrande's figs. 41, 42 (Woodcut, Fig. 2), and 44. His figures unfortunately do not give the side view for comparison,—only an imperfect vertical section, fig. 43.

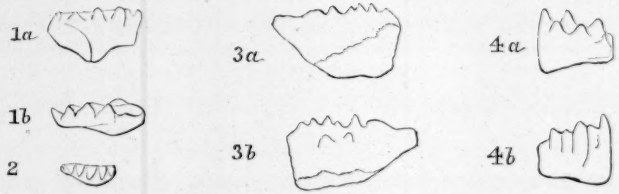
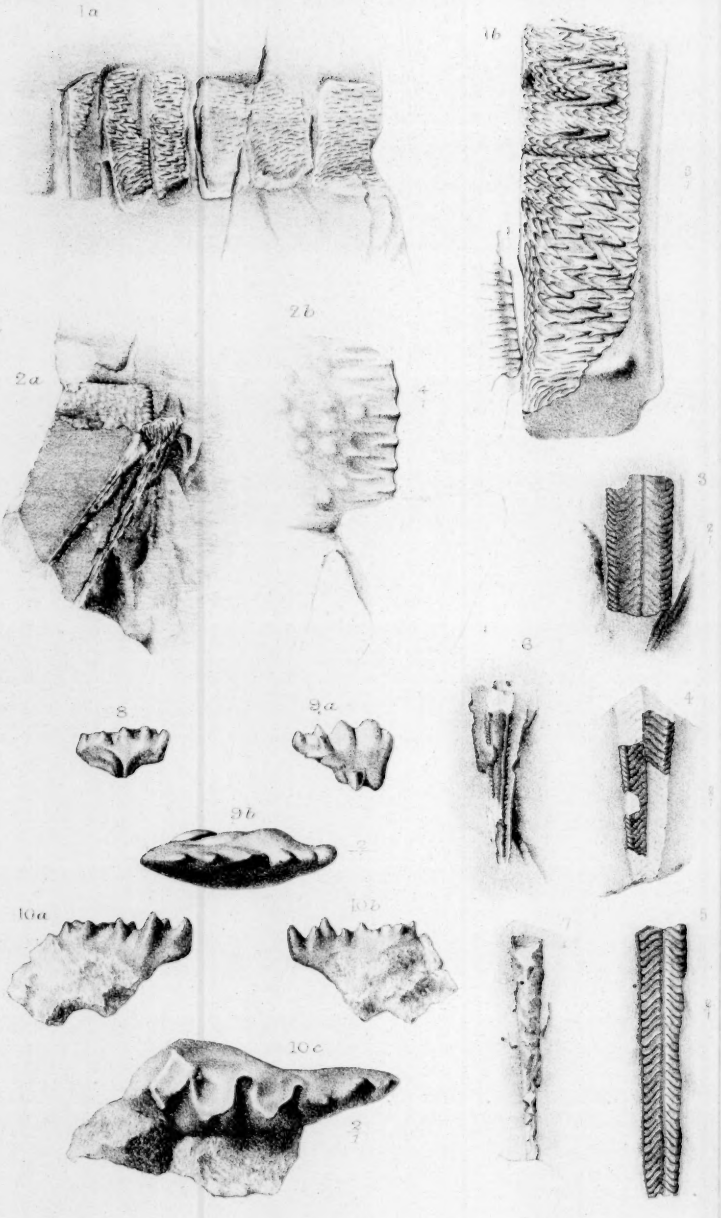


Fig. 1 *a*. Side view of a "tooth"; the same as Pl. VI. Fig. 8. From Fårö. Nat. size.
,, 1 *b*. The same, seen from the top edge.
,, 2. A somewhat similar "tooth," seen from the top. Barrande's pl. 21, fig. 42 *a*, p. 443. From the Stage E of Bohemia. Nat. size.
,, 3 *a*. Side view of a "tooth." From Fårö. Nat. size.
,, 3 *b*. The other side of the same.
,, 4 *a*. Side view of a "tooth." From Fårö. Nat. size.
,, 4 *b*. The other side of the same.

Pl. VI. Fig. 9 *a*, *b* (14 mm. long) presents another shape altogether, inasmuch as the cusps keep nearly all in a single row without the



F. C. Knight, lith. Mintern Bros. imp.

Scandinavian Phyllocarida.

flexuous or zigzag ridge. They are six in number, blunt, and differing much in size one from another; the middle of the body of the "tooth" is thicker than the ends.

Two other specimens from the same locality have the cusps more distinctly arranged in two rows and somewhat alternating (Woodcuts, Figs. 3 and 4). These in some respects approach fig. 21 in Barrande's pl. 31. One of them is 17 mm., and the other (imperfect?) 10 mm.

All the Scandinavian specimens of Crustacean teeth here mentioned are from the Upper Silurian of the Isle of Färö, off the North-eastern extremity of Gothland.

British specimens.—Fossil carapace-valves having irregular marks due to the presence of "teeth" within the squeezed valves of the carapace are not unusual in the collections from Lanarkshire. In the British Museum, "No. 58878." from Linburn, near Muirkirk, Lanarkshire, is a specimen showing a pair of "teeth," each 8 mm. long, with six cusps, longer at one end of the "tooth" than the other (Woodcut, Fig. 7). Also another, "No. 45160," figured in the Geol. Mag. 1865, Pl. XI. Fig. 2, from Lesmahago (Woodcut, Fig. 5). This measures 9 mm. long, and has an oblique basal portion, 10 mm. long. In the University Museum at Cambridge are two specimens. One of them, "*b*/11," imperfect, with only four, rather long and irregular cusps (Woodcut, Fig. 7), is from Beck Mills, near Kendal (Upper-Ludlow Beds), and measures 6 mm. in length; and the other, "*b*/136," from Lesmahago, Lanarkshire, has seven cusps, and is 12 mm. long, with an oblique root 15 mm. long; the cusps are high and sharp at one end, and small and blunt at the other (Woodcut, Fig. 6). Referring to Geol. Mag. 1865, we see in Pl. XI. Fig. 1 (*Ceratiocaris papilio*, also from Lesmahago) that the "teeth" are made to appear as being opposed one to the other vertically (Woodcut, Fig. 9); this is, without doubt, due to the compression of the carapace, and to their being squeezed against the inside of the valves. In their normal position they would be opposed to each other horizontally, or nearly so. As regards the shape of these "teeth," they resemble that of the others in the British Museum and those in the Cambridge Museum. In the Glasgow University Museum a fine example of *C. stygia* has similar teeth, also placed within the anterior portion of the carapace. All of these, however, have their cusps smaller and more regular than those in our Pl. VI. Fig. 10; they do not quite agree with our Fig. 8, which is probably allied to Barrande's pl. 21, figs. 41-44 (judging chiefly from the upper surface); and they differ much from our Pl. VI. Fig. 9.

The specimens in the British Museum (Nos. 45160 and 58878), and the more perfect specimen of the two in the Cambridge Museum, differ materially from the Bohemian and Scandinavian specimens in the more trenchant character of their cutting edges, and in the broad elongated bases of attachment, suggesting that we may be here dealing with two forms of masticatory organs,—namely, (1) a thicker

and more solid form, being probably true gastric teeth; and (2) a compressed trenchant type, being a portion of the true mandible. Some, indeed, of the European forms also may have belonged to this latter type; but, as the bases (if ever existent) have been broken off in the Gothland examples, and hidden in the figures of those from Bohemia, we are unable to speak with confidence as to this part of their structure. The differences, moreover, in the material in which they have been imbedded, and in the conditions of pressure and fossilization, may have modified the organisms to a very considerable degree.

Fig. 5. Specimen "45160" in British Museum. From Lesmahago. Nat. size.
,, 6. Specimen "*b*/136" in Cambridge Museum. From Lesmahago. Nat. size.
,, 7. Specimen "58878" in British Museum. From Lesmahago. Nat. size.
,, 8. Specimen "*b*/11" in Cambridge Mus. From Beck Mills, Kendal. Nat. size.
,, 9. Part of specimen "47989" in the British Museum, showing the position of the "teeth" in the anterior region of the carapace of *Ceratiocaris papilio*. From Lesmahago, Lanarkshire. Nat. size.

We cannot pretend to refer these fossil teeth to the known species of *Ceratiocaris;* but evidently there are six different forms; thus:—

1. With neatly chevron-shaped cusps, regular in size. Woodcut, Fig. 2. Barrande's pl. 18, f. 2 (?); pl. 21, f. 41–44; and Pl. VI. Fig. 8.
2. Small neat cusps, longer at one end of the tooth than at the other. Woodcuts, Figs. 5, 6, 7, 8 (?), 9.
3. Cusps with a more flexuous connecting ridge. Pl. VI. Figs. 10 *a*, 10 *b*, 10 *c*.
4. Cusps in two parallel rows, but somewhat alternate. Barrande's pl. 31, f. 21.
5. Cusps irregularly alternate in two rows. Woodcuts, Figs. 3 and 4.
6. Cusps in a single row. Pl. VI. Figs. 9 *a*, 9 *b*.

Note.—It may be well to mention that in the "Quart. Journ. Geol. Soc." vol. xvii. 1861, pp. 542–552, pl. 17, Dr. J. Harley described and figured numerous small, waterworn, organic fragments from the Ludlow Bone-bed, under the generic name of *Astacoderma*; and he referred them to a Crustacean origin, mostly as being morsels of the harder parts of tests and limbs, but in two instances as having some resemblance to "the stomach-teeth of the common Lobster" (p. 550, pl. 17, figs. 11–13). In "Siluria," 3rd (called the "4th") edit. 1867, p. 542, it was suggested that all the specimens figured by Dr. Harley, excepting figs. 15 and 16, were really portions of the teeth of Phyllopod Crustaceans such as *Ceratiocaris*.

II. Phasganocaris, Novák.

Sitzungsb. k. böhm. Gesell. Wissensch. 1886, p. 1, pl. i.

1. Phasganocaris pugio (*Eurypterus*, Barrande[1]), Novák. *Loc. cit.*

1*. Phasganocaris pugio (Barrande), var. serrata, J. & W.
Plate VI. Figs. 3–7.

Fifth Report on the Palæozoic Phyllopoda, 1887, p. 3; Report Brit. Assoc. for 1887 (1888), p. 62.

Four flattened pieces (Figs. 3–6) of tapering, riband-like telsons, with a central line, sometimes raised, but usually sunken, which was originally a ridge in all probability. From it, on each side, numerous parallel, oblique, sigmoid lines pass downwards and outwards, and these end at the edges with sharp upward curves, defining the small sub-triangular teeth of a serrated fringe. This is of varying strength, and is sometimes backed by a slight ridge. Except in the serrated edges these specimens correspond in essential particulars with the *dorsal* aspect of the triangular or bayonet-like lower portion of the telsons referred by Barrande to *Eurypterus*, but by O. Novák, lately and with precision, to his new genus *Phasganocaris*.

These fragments, dark brown and chitinous in appearance, are in an earthy yellowish-grey limestone (Lower Ludlow) from Vattenfallet (the Waterfall) near Wisby, Gothland.

Fig. 7 shows a longer and narrower piece of a telson, badly preserved, much crushed and wrinkled, but retaining some convexity, and its upper end showing a slightly triangular section. It is dark-brown and chitinous, in a blue-grey, calcareous, and finely micaceous shale (of the Ludlow series), from the Ringsjön, Scania.

EXPLANATION OF PLATE VI.

Fig. 1. *Ceratiocaris Scharyi*, Barrande. 1 *a*, abdominal segments; nat. size. 1 *b*, one of the segments and part of another, magnified 3 diam. The Ringsjön, Scania.

„ 2. *C. pectinata*, J. & W. 2 *a*, ultimate segment, telson (style), and one stylet; nat. size. 2 *b*, a portion of the segments, magnified 4 diam. The Ringsjön.

„ 3, 4, 5. *Phasganocaris pugio* (Barr.), var. *serrata*, J. & W. Portions of telsons, magnified 2 diam., and Fig. 6, nat. size. From Vattenfallet, Wisby, Gothland.

„ 7. *P. pugio*, var. *serrata*, J. & W., nat. size. From the Ringsjön, Scania.

„ 8. Tooth of *Ceratiocaris*; side view; nat. size.

„ 9. Tooth of *Ceratiocaris*. 9 *a*, side view; nat. size. 9 *b*, top view; magn. 2 diam.

„ 10. Tooth of *Ceratiocaris*. 10 *a* and 10 *b*, side views; nat. size. 10 *c*, top view. Magn. 2 diam.

Figs. 8–10 are from the Isle of Fårö, north of Gothland.

Supplemental Note on Ceratiocaris Angelini. Pl. V. Fig. 1.

Prof. Lindström has favoured us with a careful sketch of the ridges and pits seen on the original specimen of *Ceratiocaris Angelini*, J. & W., but very obscure on the plaster cast. He writes (Mar. 2): "The tip of the telson in *Cer. Angelini* is only slightly longer than

[1] *E. pugio*, Barr. Sil. Syst. Bohême, vol. i. Suppl. p. 564, pl. xxvi. figs. 25–34, and pl. xxxiv. figs. 7–9.

that of the plaster cast. Its total length is 148 mm., and there is thus a difference of only 7 mm. between the original and your figure. I enclose a fairly good sketch of the row of impressions on the left side of the telson as seen in the original. They are visible for a length of 57 millim. from the broken tip upwards and are very small, about 14 being contained within a length of five millimètres."

Fig. 10. A small portion of the original specimen of the telson of *Ceratiocaris Angelini*, from the left-hand side, as figured in Plate V. Fig. 1. Magnified 4 diameters.

II.—On the Structure of *Cleistopora* (*Michelinia*) *geometrica*, Edwards & Haime, sp.

By H. Alleyne Nicholson, M.D., D.Sc., F.G.S.,
Regius Professor of Natural History in the University of Aberdeen.

In their great work upon the Palæozoic Corals (Polypiers Foss. des Terr. Pal. p. 252, pl. 17, figs. 3, 3a, 1851) Milne Edwards and Haime describe and figure, under the name of *Michelinia geometrica*, a remarkable little Coral from the Devonian rocks of France. By the kindness of Dr. Daniel Œhlert, of Laval, whose researches upon the stratigraphy and palæontology of the French Devonian rocks are well known, I have been enabled to examine some well-preserved examples of this interesting form, and have determined some new facts as to its internal structure. Investigation by means of thin sections has, in fact, shown that this Coral has in reality no close relationships with the genus *Michelinia*, but that its affinities are rather with *Protaræa*, E. & H. It differs, however, in important structural features from *Protaræa*, and appears to form the type of a new genus to which the name *Cleistopora* may be given.

Cleistopora geometrica, E. and H. sp. (Fig. 1, A), is a little discoid Coral, averaging from one and a half to two centimètres in diameter, from two to three millimètres in thickness in the middle, and usually attached parasitically to a Brachiopod or other foreign body. In some cases it appears to have been free. The short vertical corallites terminate in shallow hexagonal calices, which are mostly from five to six millimètres in diameter. The floor of each calice is formed by a flat or slightly convex surface, more or less clearly reticulated, which was regarded by Milne Edwards and Haime as being constituted by the highest of the "tabulæ," which they supposed to possess a strongly granulated exterior. Examination by means of thin sections (Fig. 1, C) shows, however, that "tabulæ" are entirely wanting, and that the whole visceral chamber, below the level of the calice, is occupied by a mass of reticulate or trabecular tissue, formed by irregularly anastomosing calcareous fibres.

This characteristic structure is shown equally well both by vertical and tangential sections (Fig. 1, C and D).

The walls of the corallites are thick, and when viewed in section under the microscope exhibit tolerably well the peculiar fibrous and suberystalline structure which is seen in sections of many recent Corals. A true "primordial wall," such as is seen in many species of *Favosites*, does not seem to be present; but the junction between adjacent corallites is usually marked by an irregular dark line. The visceral cavities of contiguous tubes are placed in communication by irregular canals, which represent the "mural pores" of the *Favositidæ*. Septa are only represented feebly, by a number of obscure ridges or striæ.

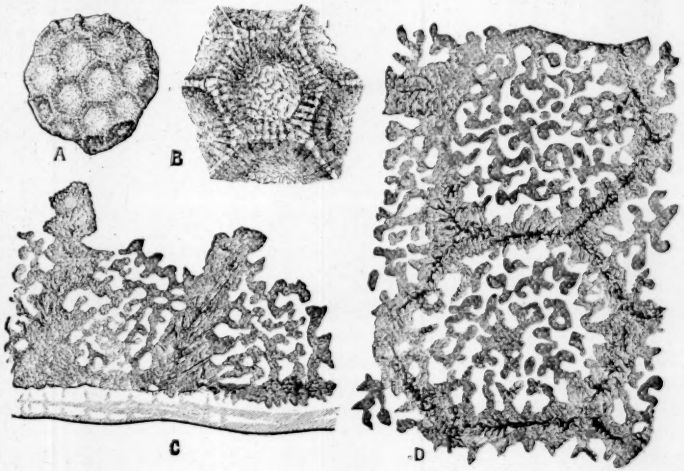


Fig. 1. *Cleistopora geometrica*, Edw. & Haime, sp. A. Upper surface of a full-sized individual, of the natural size. B. A single calice enlarged. C. Vertical section of a specimen growing upon a Brachiopod, enlarged five times. D. Tangential section of the same specimen similarly enlarged.

From the above description it will be evident that *Cleistopora geometrica* E. & H. sp., is a Perforate Madreporarian, and that it is related to *Protarœa*, E. & H. In this latter genus, however, the visceral chambers of the corallites are very short, and are not filled up in their basal portion with the reticulated endothecal tissue, which is characteristic of the genus *Cleistopora*.

From the genus *Michelinia*, De Kon., *Cleistopora* is sufficiently separated, not only by the possession of the peculiar trabecular infilling of the lower part of the visceral chambers, but also by the total absence of tabulæ, while the "mural pores" are only represented by vermicular and tortuous tubes passing through the walls of the corallites. In the general aspect of the corallum, *Cleistopora geometrica* presents a considerable resemblance to the species of *Pleurodictyum*, Golf., from which, however, it is separated by characters similar to those which distinguish it from *Michelinia*.

Another distinctive character in *Pleurodictyum*—which I have recently determined by an examination of well-preserved specimens from the Corniferous Limestone of North America—is that in this genus the basal epithecal plate is pierced by numerous well-marked foramina, formed by the external openings of the mural pores of the marginal corallites. It is probable that this character will be found to be constant in the genus *Pleurodictyum*, but I am not at present in a position to affirm that it is so.

The genus *Cleistopora*, Nich., may be defined as follows:—Corallum small, discoid, usually attached by its entire base to foreign bodies. Corallites short, prismatic, without tabulæ, and having the inferior portion of the visceral chamber completely filled up with loosely reticulate calcareous tissue. Septa represented by striæ only. Walls thick, traversed by minute irregular canals or pores.

The specimens of *Cleistopora geometrica*, E. & H. sp., which I have examined, were collected by Dr. Daniel Œhlert in the Devonian rocks of Viré, France.

III.—On the Occurrence of a *Ceratozamia* in the Tertiary Flora of Leoben in Styria.

By Dr. Constantin Baron von Ettingshausen, F.C.G.S.,
Professor of Botany, University of Graz, Austria.

MR. ADOLPH HOFFMANN has kindly sent me a large series of fossil plants from the Tertiary strata of Leoben containing a very rich fossil flora. On examining the latter, I discovered a fossil leaf, which I at once recognized as a *Cycad*.

Remains of that family of plants are extraordinarily rare in the Tertiary strata of Europe. They are limited almost entirely to the Eocene formation. The occurrence, therefore, of such a fossil in the Tertiary flora of Leoben, which belongs to the Miocene period, calls forth the greatest interest, and I shall not fail to give a preliminary notice on the subject to palæontologists.

The leaf-fossil resembles very much the leaf of *Ceratozamia*, a Mexican genus. It shows lanceolate-linear segments which are narrowed towards both ends and somewhat falciform. The borders are not toothed. The segments are 17 centimètres long and 17½ millimètres broad. The texture is firm, coriaceous. The nervation consists of 16 longitudinal nerves, being equally thin and undivided. They are rather prominent. The epidermis is well preserved and shows stomata which, relating to form and position, agree very closely with those of *Ceratozamia*.

Though I do not doubt that the fossil here described is a *Cycad*, it is well to take into consideration other possible determinations. In the first place there are the Coniferæ to be named to which the above fossil may be referred, especially the genus *Dammara*. But the leaves of the *Dammara*-species are simple, not divided, and relatively broader than the segments of the fossil in question, though structure and nervation do not differ in either. On account of the

longitudinal nerves being prominent, one might even be tempted, in determining this fossil, to consider the Gramineæ also. But the firm texture and the quality of the epidermis of the leaf do not admit of such a view.

I have named the species *Ceratozamia Hoffmanni*. The fossil leaf above described will be figured in my Memoir on the Tertiary Flora of Leoben.

IV.—Correlation of the Lincolnshire Pleistocene Deposits with those of the Midland Counties.

By R. M. Deeley, Esq.

THE Memoir of the Geological Survey on "The Geology of Part of East Lincolnshire," by A. J. Jukes-Browne, lately reviewed in the Geological Magazine, proves so interesting that I am tempted to compare the classification of the Glacial deposits which he has adopted with that I have proposed for the Midland Counties. There are also some features in the distribution and lithological characters of the Boulder Clays to which I should like to draw attention.

At the outset Mr. Jukes-Browne shows that there are in Lincolnshire two types of Boulder Clay occupying areas separated from each other by the Chalk Wolds. These two deposits, which he regards as having been formed at different stages of the Pleistocene period, are described as the "Older" and the "Newer Boulder Clay." The Older Boulder Clay, the Chalky Boulder Clay of Mr. Searles Wood, an intensely chalky deposit, is only found on the west side of Sheet 84 of the Ordnance Survey. The Newer deposits are brown or purple clays, which rise up from beneath the alluvium stretching along the coast. Both these deposits contain intercalated beds of sand or gravel. In a paper printed in the Quart. Journ. Geological Soc. vol. xli. p. 114, Mr. Jukes-Browne shows that the brown or purple clays, generally known as the Hessle and Purple Clays, frequently occupy interglacial valleys cut through the older Chalky Boulder Clay. In my own paper I found it most convenient to divide the Pleistocene period into three epochs, namely, Older, Middle, and Newer Pleistocene, the Great Chalky Boulder Clay and associated chalky gravels being relegated to the Middle Pleistocene division, an arrangement which might also be adopted for the similar deposits of Lincolnshire. As far as I am aware the only Older Pleistocene deposit in this county is the mass of Quartzose Sand on the hill near Gelston, north of Grantham. A careful search would doubtless reveal many other sections both of Boulder Clay and gravel. Too much reliance must not be placed on the colour of a deposit. Similarity of colour no doubt indicates that the materials forming the different deposits have been derived from similar rocks, but we must not be too ready to assume that it also indicates similarity of age. In the Midland Counties the adoption of such a test would lead to great confusion, for in this area the Older and Newer Pleistocene clays, having been generally formed by the breaking up of similar rocks, are somewhat similar in colour,

and yet they are separated from each other by the whole of the Middle Pleistocene series.

I do not mean to affirm that on this account the classification adopted by Mr. Jukes-Browne is incorrect, but it is possible that some of the brown and purple clays he describes belong to the Older and not to the Newer Pleistocene series. Such deposits would be difficult to recognize on the east side of the Chalk Wolds, as they would contain chalk and flint; but on the west the comparative scarcity or even total absence of these rocks should render their detection tolerably easy. In the Trent Basin, south and west of Newark, there are no signs of a submergence having occurred in Newer Pleistocene times. With the close of the Middle Pleistocene epoch marine conditions came to an end, and rivers commenced to re-excavate their valleys through the masses of Boulder Clay and sand which had been formed in them. Subaerial erosion also seems to have been active in Lincolnshire at the same time, for there the Newer Pleistocene Hessle and Purple Boulder Clays are found at low levels in valleys excavated subsequently to the formation of the Chalky Boulder Clay. This would make the Later Pennine Boulder Clay of the Midland Counties the equivalent of the Hessle and Purple Clays. In the Trent Basin, as I have remarked, the Later Pennine Boulder Clay shows no signs of aqueous action, whereas the equivalent low-level deposits in Lincolnshire seem to be of marine origin. If we admit the possibility of a Newer Pleistocene submergence of about 400 feet, such as Mr. Jukes-Browne requires, great difficulties present themselves; indeed, it would be necessary to assume great but local earth-movements without we imagine the whole of Central England to have been occupied by an ice-sheet, which displaced the water. The severity of the glacial conditions which really obtained in Newer Pleistocene times is as yet scarcely realized, yet at this age the cold was sufficiently severe to permanently freeze the ground in the South of England, and bring down great glaciers from the Cambrian and Cumbrian Mountains, which, spreading over Lancashire and Cheshire, eventually passed over the watershed into the Trent Basin. I am aware that this is disputed, many geologists regarding the striæ as being due to large icebergs grating along the bottom of a sea about 1200 feet deep; glaciers being with them at a discount. Now an iceberg is merely a fragment of a glacier, and therefore the larger the iceberg the larger the glacier. Consequently I prefer to make my glaciers larger than my icebergs, not *vice versa*.

During the Middle Pleistocene epoch the ice-flow seems to have passed from the north-east over the submerged Chalk Wolds, giving rise to the intensely Chalky Boulder-clay. At a still later stage, in Newer Pleistocene times, the ice came from the Pennine Hills or further west, and passing down the Trent Valley, pressed against the escarpment of the Middle Oolite. Through the gaps of the Humber and Witham Valleys the subglacial streams poured their sediment into the sea forming the Purple Clays. At one time it is probable that the ice actually passed out through the Witham and

Humber Valleys, or even over the Wolds as well, giving rise to the more chalky Hessle Clay. Before accepting a submergence of 400 feet, very strong proofs will have to be furnished, not only of the marine aspect of the high-level brown Boulder Clays, but also of their Newer Pleistocene age.

V.—Avalanches and Avalanche Blasts.—"Winter in the High Alps."

By John Addington Symonds, Esq.

THE following important and interesting notes on avalanches and the dangerous wind-blasts they cause, appeared in the *Pall Mall Gazette* for February 28th, 1888. As we do not remember to have seen the geological effects of these phenomena described in any detail in our numerous geological text-books, we believe Mr. Symonds' notes on the subject will be of much interest to readers of the Geological Magazine.

"*Feb.* 6.—We reckoned another foot of snow this morning. The Fluela Pass, which connects us with the Lower Engadine, was closed to traffic. Just before noon a man called Anton Broher, known among his comrades as "the Knave of Spades," because he had a bushy black beard, was swept away by an avalanche below Tschuggen, on the Fluela road, about three miles from Davos Platz. Eye-witnesses saw him carried by the blast of the avalanche, together with his horse and sledge, three hundred yards in the air across the mountain stream. The snow which followed buried him. He was subsequently dug out dead, with his horse dead, and the sledge beside him. The harness had been blown to ribbons in the air; for nothing could be found of it, except the head-piece on the horse's neck.

This violence of the wind which precedes an avalanche is well authenticated. A carter, whom I know, once told me that he was driving his sledge with two horses on the Albula Pass, when an avalanche fell upon the opposite side of the gorge. It did not catch him. But the blast carried him and his horses and the sledge at one swoop over into deep snow, whence they emerged with difficulty. Another man, who is well known to me, showed me a spot in the Schaufigg Valley (between Chur and the Streda Pass) where one of his female relatives had been caught by the wind of an avalanche. She was walking to church when this happened. The blast lifted her into the air, swept her from the road, and landed her at the top of a lofty pine, to which she clung with all the energy of desperation, The snow rushed under her, and left the pine standing. It must have been a trifling avalanche. Her friends, returning from church, saw her clutching for bare life upon the tree, and rescued her. Many such cases could be mentioned. A road-maker named Schorta this winter was blown in like manner into the air below Zernetz, and saved himself by grappling to a fir tree. I have been shown a place near Ems, in the Rhine Valley, not far from Chur, where a miller's house was carried some distance through the air by an

avalanche blast. Its inhabitants were all killed, except an old man above sixty and a child of two years. Again, I may mention that the tower of the monastery at Dissentis was on one occasion blown down by the same cause. In order to understand the force of the "Lavinen-Dunst," as this blast is called here, we must remember that hundreds of thousands of tons of snow are suddenly set in motion in narrow chasms. The air displaced before them acts upon objects in their way like breath blown into a pea-shooter.

Feb. 7.—It is still snowing. We reckon that there is an average depth of five feet in the valley. In the woods, and where it has drifted, the snow is of course much deeper. Four large avalanches fell to-day between Frauenkirch and Schmelzboden. One of them, in the Rutsch-tobel, below Monstein, caught some men working on the road. The man in advance, Caspar Valär, was blown across the stream and buried. The others managed to extricate themselves.

I have since then seen this avalanche. It covers about five acres in the valley, and has a depth in the deepest place of at least sixty feet. The trees on a hill above it have been mown down by the violence of the wind it carried [sucked after it ?].

Feb. 9.—It is still snowing. The road between Davos and Wiesen is said to be impassable. The electric light is extinct in Davos Platz to-night, owing to an immense avalanche, which fell in the Dischma Thal and choked the water supply,

I must observe that when there is a considerable frost, the snow does not get easily into motion, and so there is less risk of avalanches. The greatest danger is when a thaw, with blustering warm wind, sets in while the snow is still falling. There are, roughly speaking, three sorts of avalanches. One is called "Staub Lavine," and descends when the snow is loose and recently fallen. It is attended with a whirlwind, which lifts the snow of a whole mountain side into the air and drives it onwards. It advances in a straight line, overwhelming every obstacle, and is by far the most formidable of the three sorts. The second is called "Grund Lavine." It falls generally in the spring-time, when the firm winter snow has been loosened by warm thawing breezes. The snow is not whirled into the air, but slips along the ground in enormous masses, gathering volume and momentum as it goes, and finding a way forward by its own weight. The third is called "Schnee-Rutsch," or snow-slip. It consists of a portion of snow detached upon a mountain slope, down which it slides gently, heaping itself gradually higher till it comes to rest on a level space. Small as the slip may be, it is very dangerous. The snow in motion catches the legs of a man, carries him off his feet, creeps up to his chest, and binds his arms to his side, being compressed by motion into a firm substance like hardening plaster of Paris. I once saw a coal cart with two horses and a man swept away by a very trifling slip of this sort. The man and one horse managed to keep their heads above it and were rescued. The other horse was stifled before he could be dug out.

Feb. 12.—Drove over the avalanches to Wiesen. At Glarus saw fifty-two men digging for the body of Caspar Valär. They have

been digging since the 7th, but in vain. His corpse will not be found until the spring. Meanwhile his widow is lying in a house which overlooks the place where her husband was overwhelmed. Avalanches have descended on both sides of the hill on which this homestead stands. The gorge which separates Davos from Wiesen, called the "Züge," or the "Paths of Avalanches," is a mere wilderness of snow shot down from either side."

That the weather this winter on the Continent has been exceptionally severe is still further shown by the following extracts from long and numerous newspaper reports:—

"Heavy snowfalls were again reported yesterday from the central districts of Northern Italy, where it is stated that in some places the snow is as much as ten feet deep. The Alpine troops with the Carabineers, under the direction and leadership of the authorities, have been working heroically in the task of rescuing the people of the small villages which have been buried in the masses of snow. By the latest accounts more than 200 bodies had been taken out. The hamlet of Trasquera, in Piedmont, at the foot of the Simplon, has been completely overwhelmed by an avalanche. In the Bini valley five persons have been killed by an avalanche.

"The strange coincidence of a violent thunderstorm and a heavy fall of snow occurring at the same time took place on Saturday morning in the Giant Mountains near Gorlitz, in Silesia.

"Two avalanches have fallen on the famous hospice of St. Bernard. The church has been almost entirely buried in snow."

(Communicated by C. Davies Sherborn, F.G.S.)

NOTICES OF MEMOIRS.

I.—*Titanichthys pharao*, nov. gen. et nov. sp., AUS DER KREIDEFORMATION AEGYPTENS. By Prof. Dr. W. DAMES. Sitzungsb. Ges. naturf. Freunde Berlin, 1887, pp. 69-72, woodcuts.

SOME detached and partially broken teeth from the Lower Senonian of Egypt are described by Dr. Dames under the name of *Titanichthys pharao*. The specimens were obtained by Dr. Schweinfurth about 10 kilometres west of the Pyramids of Gizeh, and, when complete, measure 60 millim. in length. They are laterally-compressed teeth, with a very long root, rapidly tapering upwards, and marked by deep longitudinal furrows. The enamelled crown is relatively small, and of an unsymmetrical arrow-head shape, overhanging the summit of the root in front and behind, and thus giving the tooth a barbed character. The genus thus imperfectly indicated is regarded as new, and placed (with *Enchodus*) in the Trichiuridæ; if really undescribed, however, it will require another name, *Titanichthys* having been preoccupied by Newberry for a huge Placoderm (Trans. New York Acad. 1885).

II.—Die Gattung *Saurodon*, Hays. By Prof. Dr. W. Dames. *Ibid.* pp. 72—78.

DURING the investigation of the teeth of *Titanichthys*, Dr. Dames was led to study the semi-barbed teeth from the European Chalk originally referred by Agassiz to the American genus and species *Saurodon Leanus*, Hays. The result is an interesting *resumé* of the varied fate of the fossils in question at the hands of different palæontologists. Their resemblance to the teeth of the Trichiuridæ is discussed, and full references are given to the several descriptions and figures. It is unfortunate, however, that Hays' original memoir has not been consulted, nor yet the most important contributions of Leidy (Trans. Amer. Phil. Soc. vol. xi.) and E. T. Newton (Quart. Journ. Geol. Soc. vol. xxxiv.). The latter authors have shown that the European fossils are certainly not referable to *Saurocephalus* (of which *Saurodon* is a synonym), and those from the English Chalk are named *Cimolichthys levesiensis*. A. S. W.

REVIEWS.

I.—Geology, Chemical, Physical, and Stratigraphical. By Joseph Prestwich, M.A., F.R.S., F.G.S. In Two Volumes. Vol. II. Stratigraphical and Physical. Royal 8vo. pp. xxviii. and 606, with Geological Map of Europe, and numerous Illustrations. (Oxford, at the Clarendon Press, 1888.)

IF the number of geological papers published every year in various parts of the globe were taken as a measure of the increase of our knowledge, our sentiments on the subject might fitly find utterance in the word "Prodigious!" Nevertheless, while this great "talus heap of geological literature," as it has been rather irreverently termed, may at times produce a feeling of dismay and oppression, yet we may derive comfort from the thought that in due course of time the leading facts and the general results of this mass of information are tabulated and expounded in the larger Text-Books and Manuals.

Our advances in geological knowledge are then best gauged by such works as the one now before us, written as it is by one of our geological leaders, and whose object it is to exhibit the present state of the science. It might indeed be maintained that we are already well supplied with Manuals of Geology—Physical, Stratigraphical, and Palæontological; but it may also fairly be urged that one individual might devote his whole time to the literature past and present, and never learn a tithe of all that has been done in geology. Consequently the deficiencies of one work are compensated by others: and while we give honoured places on our bookshelves to the general Manuals of the older geologists—to Buckland, Bakewell, Trimmer, De la Beche, Phillips, Lyell, and Jukes, the value of whose works is now to a large extent historical; so alongside of Geikie, Green, Seeley, and Etheridge, we accord a hearty welcome to the two handsome volumes by the ex-Professor of Geology at Oxford.

Two years have elapsed since the publication of the first volume of Prof. Prestwich's work (see notice in GEOL. MAG. for 1886, p. 81), but the delay is amply explained by the amount of labour involved in the preparation of this second and larger volume—indeed the illustrations alone must have cost the author a very great deal of thought and attention. With regard to the aspect of the volume itself, we can only repeat what was said before, and speak in the highest terms of the clearness of the type, the excellence of the paper, and the beauty of the woodcuts and lithographic plates. In the matter of illustrations this second volume is even more profusely adorned than its predecessor. The large map of Europe, printed in colours and mounted on linen, which acts as a folding frontispiece, will in itself be a treasure to geologists. It is the work of Mr. W. Topley and Mr. J. G. Goodchild, and shows very clearly the distribution of the principal geological formations. Besides 256 woodcuts, a large number of which have been expressly engraved for this work, there are 16 lithographic plates showing characteristic fossils of different formations; they have been drawn on stone by Miss Gertrude Woodward, and we may observe that we have seldom seen in any geological work illustrations which for beauty and accuracy are equal to these. The woodcuts include pictorial views of scenery as well as groups of fossils, and sections to show the structure of various districts; and there is also a map showing the probable extent of land covered by ice and snow during the Glacial Period. It is no exaggeration then to state that this is the best printed and best illustrated geological text-book that has been produced in this country.

The former volume dealt with rocks, sedimentary and eruptive, and their method of formation; it treated of ice and ice-action, coral-islands, earthquakes and volcanoes, underground water and springs, metalliferous deposits, and metamorphism.

The present work is mainly devoted to the geological history of the stratified rocks. Commencing with a brief account of the early conditions of the earth's crust, the author gives a condensed account of the various formations in ascending order, pointing out their chief physical features, the forms of life represented at each great period, and the distribution of the rocks over the surface of the globe.

In such a comprehensive survey it is impossible to enter into much detail respecting the minor divisions of the rocks, and their varying lithological characters, but strict impartiality so to speak in dealing with different formations is apt to detract from originality, and may well be pardoned. Nevertheless we feel that some formations have received but scant courtesy, and this remark refers especially to the Devonian rocks and Old Red Sandstone, and to the Carboniferous Limestone Series. On the other hand, the Corallian rocks and some of the Tertiary strata are treated in considerable detail. But while the stratigraphical features of the rocks are for the most part dealt with in a broad and general way, their palæontology is very fully discussed. The leading genera and many of the species are enumerated, while palæontological summaries are given of the life of the larger divisions of the strata, showing the

period of incoming of the different classes, and the orders and genera peculiar to the Palæozoic, Mesozoic, and Kainozoic eras. In the various tables which he has prepared the author acknowledges his indebtedness to the elaborate work on Stratigraphical Geology and Palæontology issued in 1885 by Mr. Etheridge.

Of great value to students will be the excellent accounts of the foreign equivalents of our strata, one of the most important features in this work. Not only are the sedimentary rocks in different parts of Europe described, together with their chief palæontological features, but the rocks so far as they have been determined in other parts of the globe are likewise mentioned: so that with the aid of the geological map of Europe prefixed to this volume, and the smaller geological map of the world prefixed to the former volume, the student can follow out the geographical distribution of the main divisions of the strata and make himself acquainted with the principal facts in their life-history. Several Tables of Strata are given in the volume before us. Table I. shows the Sedimentary Strata in England and their Correlation with some of the principal Continental Groups. Then follow Tables of the formations in India, North America, Australia, New Zealand, and South Africa; these include lists of the characteristic fossil genera of the principal divisions, and a column showing the probable age of the formations compared with the general "time-divisions" in Europe.

It appears likely that the Table of English formations was printed off some time before the rest of the work was in type, for we notice several discrepancies between the grouping adopted in the table and that in the text. Thus in the former the Folkestone Beds are placed with the Gault, and in the latter they are grouped with the Lower Greensand. The Lenham Sands are doubtfully placed with the Miocene in the Table, and later on they are provisionally placed with the Pliocene; the Bure Valley Crag is classed as pre-Glacial in the Table, while in the text further on it is grouped with the Pliocene as part of the Norwich Crag. Moreover, in this Table the Recent deposits are not given so much prominence as they are in Table II., and curiously enough they are separated from the Quaternary Period. The term Kainozoic should be employed as a comprehensive term to embrace both Tertiary and Quaternary.

The terms pre-Glacial and post-Glacial are still used by Prof. Prestwich, although vague terms of this character are much to be deprecated, as they are liable to be used in different senses by different writers, and they have thus no definite chronological value. Noteworthy instances of this have occurred at recent meetings of the Geological Society.

The term Oligocene is adopted, the Permian is grouped with the Palæozoic, while the Silurian is employed in the old Murchisonian sense, although the term Ordovician, now very largely used for the "Lower Silurian" strata, is mentioned in a footnote. On the whole, however, we are glad to find that the old familiar names of formations are used by the author.

If the labours of original workers are more or less hidden in

the "talus" before mentioned, so we naturally look for a due record and acknowledgment of them by those who have sifted out and sorted the facts; and the long list of authorities referred to or quoted by Prof. Prestwich will testify to his laborious research. Even then we miss some well-known names, but when we remember that the "talus" includes 43 volumes of the Quarterly Journal, 24 Geological Magazines, 41 volumes of the Palæontographical Society, not to mention countless other Journals, Transactions and Proceedings at home and abroad, some omissions are not surprising, for even the "Geological Record" has failed to keep pace with these publications.[1] And among the long list of papers there are many whose interest is purely local, and others that tend but little to advance our general knowledge. It might be observed, however, that authors would facilitate the study of the literature were each one to add a summary of his views and conclusions at the end of his papers.

Geology is indebted, however, not only to those who have written papers on various subjects: it is also largely indebted to many individuals who have never committed their views to print. This is particularly the case with our local geologists who have accumulated large collections of fossils, and who are ever ready to communicate their knowledge to those who come in search of it.

In reviewing the present work we naturally turn to portions which deal with debateable subjects, but as a rule we do not find special verdicts on vexed stratigraphical questions, even when we might expect them, the reader being left to form his own judgment; the most original portions of the book are those which deal with questions in physical geology.

In briefly treating of the Archæan rocks, the author observes that "although great heat and pressure might effect radical changes in early sediments when covered up by thick masses of newer rocks,—as are the gneissic rocks of North-Western Scotland, or the felsitic rocks of Wales, by overlying Cambrian and Silurian strata,—they would not affect Archæan areas such as those of North America and Scandinavia, which we have reason to suppose have never been covered, or only to a very slight extent, by newer strata, and which, nevertheless, exhibit either the effects of intense metamorphism, or else the effects of hydro-thermal conditions originally different." These views will no doubt interest students of these ancient rocks; we may also note that the organic nature of *Eozoon* is practically accepted by the author.

In his account of the Cambrian and Silurian rocks some mention of Barrande's 'Colonies' might have been given, and also of Mr. Marr's modified interpretation of them.

The author considers that, during the Coal-period, the atmosphere was more dense, and more charged with moisture and carbonic acid, and he is led "to conclude that the coal-growth was in all probability one of extreme rapidity, and consisted of woods and plants contain-

[1] The Geological Record for 1879 was published in 1887.

ing a much larger proportion of carbon than any existing forest vegetation." With regard to the excess of carbonic acid gas, Mr. Carruthers has expressed an adverse opinion, and experiments made on living plants have shown that they are liable to be poisoned, like animals, by an excess of the gas.[1]

On the question of the duration of Coal, Prof. Prestwich adheres to the opinion expressed by the Royal Commission of 1871, that allowing for the rapidly increasing rate of consumption, the supply may last for about 400 years. It is interesting to learn that a coal-pit at Ashton Moss in the Manchester Coal-field has recently been sunk to the great depth of 2850 feet, and another pit in Belgium to 3411 feet.

In dealing with the Permian and Triassic rocks the author refers to the great earth-movements that took place before and between these periods, but it is not perhaps sufficiently pointed out that in this country the greatest physical break is at the base of the Permian. With regard to the Trias, the central division known on the Continent as the Muschelkalk "is wanting, unless it be represented by the 'Water-stones.'" Here some allusion might have been made to the sequence of Red Rocks in Devonshire, and to Mr. Ussher's subdivisions of Upper, Middle, and Lower Trias.

The author devotes some space to the subjects of rock-salt and gypsum, and illustrates his remarks with an account of a boring in Haute-Saône. The origin of the colour of the red rocks and the causes of the rarity of fossils are also discussed.

The Rhætic Beds are grouped with the Trias, but the White Lias is divorced from them and placed with the "Infra-Lias." This is not a happy arrangement, especially too when the White Lias and Sutton Stone are associated and their fossils intermingled. The latter deposit was grouped by Charles Moore in the Zone of *Ammonites angulatus*, and although this is a debateable subject, yet in the tabular arrangement given by Prof. Prestwich (p. 175) we have the "White Lias and Sutton Stone Beds" with *A. angulatus*, *Lima gigantea*, etc., placed below the zone of *Ammonites planorbis*. The White Lias is distinguished from the Lower Lias by the absence of Cephalopoda, while it contains *Cardium Rhæticum*, *Pecten Valoniensis*, *Lima præcursor*, and species of *Pleurophorus*, *Axinus*, etc., that link it with the *Avicula-contorta* shales. Moreover, at the localities mentioned, where the surface of the Rhætic beds is said to be eroded, it is above the *White Lias* that this "slight break" locally occurs.

A tabular list of the Lias zones is given (pp. 182, 183), including those of *A. opalinus* and *A. Jurensis*, the Midford Sands being taken in with the Lias, although regarded as passage-beds between that formation and the Inferior Oolite. In this table *A. capricornus* should come below *A. margaritatus*. We are glad to see that Prof. Prestwich prefers the old generic name of *Ammonites* to the many subgeneric names introduced by some palæontologists. A full general account of the organic remains of the Lias is given.

The various divisions of the Oolites are treated mainly from a

[1] See Geol. Mag. 1869, p. 300, 1871, p. 497.

West of England point of view, but there are short accounts of the beds in the Midland counties, Lincolnshire and Yorkshire.[1]

Passing on to the Cretaceous chapters, we miss a reference to Mr. Meyer's observations on the "Punfield Formation," for these to a certain extent tended to destroy its individuality. The various divisions of the Wealden and Lower Greensand, however, are briefly noticed, and the more marked physical changes are pointed out. The unconformity and overlap of the Lower Greensand where it rests on the Jurassic rocks in Wiltshire and other parts of the country is in reality more pronounced than the word '*slight*' seems to indicate.

With regard to the Greensand of Blackdown much information has been given in papers by the Rev. W. Downes, while Mr. Meyer relinquished the opinion that any part of the formation was synchronous with the Upper Neocomian (Quart. Journ. Geol. Soc. vol. xli. p. 27).

The account of the Chalk and its origin, together with that of the flints, will be read with interest. Prof. Prestwich is of opinion "that during the sedimentation of the Upper Gault, Greensand, and Lower Chalk, silica, held in solution by alkalies or carbonic acid, was introduced in exceptional quantities into the Cretaceous seas by rivers and springs, and that it there underwent decomposition in presence of some of the sea-salts." We must, however, refer our readers to the work itself for the amplification of these views, the author concluding that "it is to the presence of silica in the peculiar condition known as soluble silica that the formation of flints is due."

The Tertiary strata call for no especial remark. On this subject, indeed, our knowledge is most largely due to Prof. Prestwich himself. The Lower Bagshot Sands, as noted in a recent paper by the author, are grouped with the Lower Eocene on account of their intimate connection with the London Clay. The Bovey Tracey Beds are discussed with the Oligocene Beds, the author remarking that the evidence brought forward by Mr. J. S. Gardner to place them in the Eocene division is "by no means conclusive."

In the Pliocene chapter the Lenham and St. Erth Beds are duly noticed, while the Coralline Crag is described under the name of "White Crag." The Cromer Forest-bed is, however, included in the "Westleton Series," and mentioned among the Pre-Glacial beds of the Quaternary Period. The Glacial beds and associated phenomena are described at some length, and the author concludes "that after the first extreme glaciation, and the formation of the Lower Boulder-clay or Till, a great depression ensued, by which Central England, Wales and Ireland, were submerged to the extent of 1500 to 2000 feet. This led apparently for a time to the inset of warm marine currents, and the introduction of a more southern marine fauna; but, as the land again rose, and the warmer currents were diverted or stayed, colder conditions resumed, and arctic

[1] We should mention that the references to figs. 1 and 2, and 5 and 6 on plate vi.; those to 4 and 5 on plate vii.; and again those to 7 and 8 on plate x. are unfortunately transposed.

Mollusca returned for a time to the coasts of Scotland." He adds that "the phenomena, as a whole, go to show that the glaciation of Great Britain was not due to a great polar ice-cap, but was of local and independent origin." With respect to the account of the supposed great thickness of Boulder-clay at Boston (p. 446), we should mention that a different interpretation of the section was given by Mr. Jukes-Browne (Quart. Journ. Geol. Soc. vol. xxxv. p. 418).

In the preface to the former volume the author announced himself as to a certain extent a non-conformist in Geology, inasmuch as he had been led to believe that in the long course of geological history, the physical forces underwent constant variation in degree and intensity of action. While we believe that strictly uniformitarian views are held by few if any geologists at the present day, we are quite ready to admit that the views put forth by Prof. Prestwich will exercise a wholesome influence on geological thought, although certain of the opinions to which we have drawn attention may possibly be regarded as somewhat extreme and "out of date." In the concluding chapters of this second volume the author discusses some of the theoretical questions on the primitive state of the earth, and the condition of its crust. Here, too, he expresses his disagreement with the notion of "the lengthened permanence, as a whole, of the ocean-troughs."

Space will prevent our mentioning many other subjects of interest discussed in this volume, but we may confidently commend it to the advanced student, the specialist, and the professor, indeed to all who seek to become acquainted with modern achievements in geological science; for all inquirers will find some matters of particular interest to them, obscure topics on which a new light is thrown, or theoretical subjects illuminated in a way differing from that usually held to be orthodox.

II.—Prof. A. Gaudry on the Permian Reptilia and Amphibia of France. ("L'Actinodon," *Nouv. Archiv. Mus. d. Hist. Nat.* vol. x. pp. 1-32, pls. i.-iii. (1887). "Les Vertébrés Fossiles des Environs d'Autun," *Mem. Soc. Hist. Nat. d'Autun*, vol. i. pp. 1-90, pls. i.-xi. (1888).

THE petroleum works in the Permian shales of Igornay and Autun in the department of Saone-et-Loire of Central France have brought to light a number of vertebrate remains which now enrich the collection of the Paris Museum, and throw much light on the fauna of this early epoch. These remains, as we learn from Prof. Gaudry's memoirs, have been collected and sent to the Museum through the exertions of MM. Roche and Bayle, and other gentlemen connected with the works; to whom all students of this branch of palæontology are deeply indebted. And it is with regret we learn that the all-pervading American competition has caused the closing of these works for the present. M. Gaudry records seven species of Reptiles and Amphibians, referred to six genera, and seven species of Fishes, arranged under five generic headings, from these deposits.

In the 4to. memoir on *Actinodon* cited above Prof. Gaudry gives us a full description of the magnificent series of remains of this interesting Labyrinthodont, of which preliminary notices have been published in previous works. The most important of these remains is the nearly entire skeleton exceeding two feet in length, of which a full-sized representation of the dorsal aspect is represented in plate i. of this memoir. In this skeleton the skull, vertebral column, pelvic girdle, and limbs are beautifully preserved; and we are glad to be able to inform our readers that Professor Gaudry has kindly presented a cast of this fine specimen to the British Museum. Other specimens exhibit the three thoracic plates on the

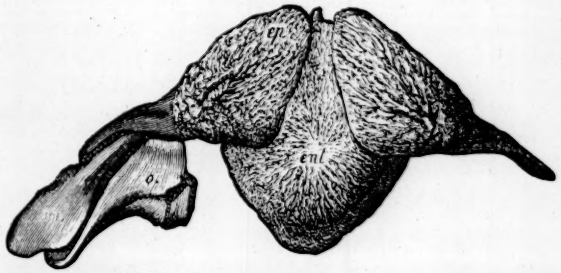


Fig. 1. Ventral aspect of the thoracic buckler of *Actinodon Frossardi*. Reduced, *ent.* interclavicle; *ep.* clavicles; *s.cl.* supraclavicle; *o.* scapula.

ventral aspect of the body (Fig. 1), which are generally correlated with the clavicles and interclavicle, and which present a strong general resemblance to the probably homologous ento- and epiplastra of the Chelonia; while other examples exhibit the dermal scutes covering the greater portion of the ventral aspect of the body. *Actinodon* belongs to a group of Labyrinthodonts confined in Europe to the Carboniferous and Permian epochs, and characterized by the so-called 'rhachitomous' structure of the vertebræ (Fig. 2). In such vertebræ the body, or centrum, is imperfectly ossified, and consists of two lateral elements termed the pleurocentra (*pl. c.*), and a median, horse-shoe-like, piece known as the intercentrum or hypocentrum (*i.c.*). Considerable discussion has taken place as to the precise homology of these elements, into which it would be out of place to enter here; but it may be observed that the general balance of opinion is in favour of regarding the hypocentra as the representatives of the centrum proper, while the intercentrum corresponds to the intervertebral wedge-bones of *Sphenodon*, and is therefore a true intercentral element. M. Gaudry, however, does not quite agree with these conclusions.

In Europe this group includes, among others, *Archegosaurus*, which is both Carboniferous and Permian, *Euchirosaurus* (Fig. 2) of the French Permian, *Cochleosaurus* from the corresponding beds of Bohemia, and *Platyops* from those of Russia. In Africa it is represented by *Rhytidosteus* of the Karoo system; in India by *Gondwanosaurus* of the Bijori beds of the Gondwanas; while the

preoccupied name *Platyceps* has been recently applied to an allied form from approximately equivalent beds in New South Wales. In the New World the strata in North America commonly termed Permian have also yielded a number of kindred forms, such as *Trimerorhachis, Eryops, Zatrachys, Cricotus,* etc. Whether these numerous forms should be referred to one or more families, or whether several of the genera will subsequently have to be united, is a matter of but little moment: their interest lying in the evidence they afford that at an early epoch of the world's history the terrestrial vertebrate life over at least a large part of the surface of the globe presented the same general *facies*. To assume, however, that these different forms existed at precisely the same absolute date in widely distant regions is clearly illogical. But if we have only

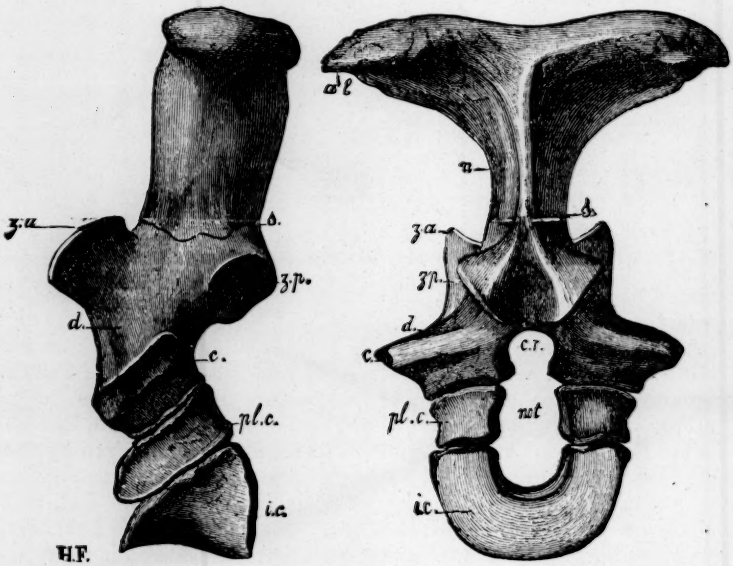


FIG. 2. Left lateral and posterior views of a vertebra of *Euchirosaurus Rochei*. nat. size. *n*. neural spine, with lateral expansions *al.*; *s*. suture between spine and arch; *za. zp.* anterior and posterior zygapophyses; *d.* transverse process; *c.* costal articulation; *pl.c.* pleurocentrum; *i.c.* intercentrum; *c.r.* neural canal; *not.* notochordal vacuity.

to reckon by the evidence of land deposits, and are careful to use the term *homotaxial equivalency* in its proper original sense (*i.e.* as essentially implying the absence of absolute synchronism), then it may be convenient to provisionally regard the deposits in which most of these Labyrinthodonts occur as of Permian, or perhaps in some cases of Lower Triassic, age. It may, however, happen that, to use Professor Huxley's graphic simile, we shall eventually be able to correct our terrestrial clock by our marine clock, when we may find that the former has lagged behind, so that our European

Permian land fauna in distant regions co-existed with an Upper Triassic marine fauna. In such an eventuality we should, of course, have to take the marine clock as the standard time-keeper.

The second memoir quoted at the head of this notice is mainly a reprint of separate articles published by the author in the Bull. Soc. Géol. France, and in the second part of his "Enchaînements du Monde Animal" (1883); and is illustrated both by woodcuts and plates. It forms the first part of a new serial commenced by the Natural History Society of Autun, which is to be congratulated on such an excellent beginning. A reduced plate is given of the skeleton of *Actinodon* already noticed, together with one of a beautifully preserved portion of the vertebral column of *Archegosaurus*; while other plates are devoted to *Haptodus*, *Euchirosaurus*, *Protriton*, *Pleuroneura*, etc. Among the Labyrinthodont forms illustrated by

FIG. 3. Slab showing the skeleton of a young individual of *Protriton petrolei*. Nat. size.

FIG. 4. Anterior aspect of the imperfect left humerus of *Stereorhachis dominans*. Nat. size.

the woodcuts, we may especially call attention to the remarkable lateral expansion of the summits of the neural spines of the vertebræ of *Euchirosaurus*, of which, by the courtesy of Prof. Gaudry, we are enabled to reproduce the illustration in Fig. 2. The probable identity of the French *Protriton* (Fig. 3) with the Bohemian *Branchiosaurus* has been already noticed in a review published by the present writer in the previous volume of this Journal. The true Reptiles found in the Autun deposits comprise *Haptodus* and *Stereorhachis*. The former is known by a considerable portion of the skeleton, although unfortunately in a much dislocated and unsatisfactory condition. Prof. Gaudry suggests that this form may be allied to

the Thuringian *Proterosaurus*, although the teeth are not implanted in distinct sockets, as was thought to be the case with the latter. Since, however, Prof. Seeley has recently shown that the latter supposition is incorrect, the alleged difference is non-existent; and the skull of *Haptodus* certainly appears to present a striking general resemblance to that of the Thuringian genus, as far as its crushed condition admits of comparison. The second genus, *Stereorhachis*, is described upon the evidence of part of the upper jaw, vertebræ, and the humerus (Fig. 4). Prof. Gaudry suggests affinity with Prof. Cope's North American genus, *Clepsydrops*, which is found in the same beds as the *Actinodon*-like Labyrinthodonts. The structure of the humerus, with its characteristic entepicondylar foramen, clearly shows that this form is a member of the suborder Theriodontia (Pelecosauria), and the probability of its belonging to the *Clepsydropidæ* appears very strong.

We may conclude not only by complimenting the learned Professor of Palæontology in the Paris Museum on the issue of these two memoirs, but with the hope that the incessant revolutions in commerce will ere long render it practicable to work the Autun oil-shales at a profit. R. L.

III.—The Solomon Islands, their Geology, etc., by H. B. Guppy, M.B., F.G.S., late Surgeon R.N. Pp. 152, with Maps and Two Plates. (Swan Sonnenschein, Lowrey & Co., 1887.)

THIS is the companion volume of a work entitled "The Solomon Islands and their Natives," which was reviewed in "Nature," Dec. 29, 1887. In his larger work the author dwelt on the ethnology, climate, natural history, botany, etc., of these Islands, and in the one now under consideration, which was published simultaneously, he deals with their geological structure and general physical features. He states in the preface that the chief value of his observations lies in the fact that his collections of the calcareous rocks and of the other recent deposits were examined by Dr. John Murray in the light of the results obtained by him from the examination of the deep-sea deposits procured by the "Challenger" and other expeditions, and also in the circumstance that the characters of the volcanic rocks were determined by Prof. Judd and Mr. T. Davies with the aid of numerous microscopic sections. Mr. H. B. Brady has likewise been engaged in examining some of the Foraminifera. A type collection of the calcareous rocks and other deposits has been placed in the Jermyn Street Museum, and the volcanic rocks are in the British Museum.

Some of the larger islands, like St. Christoval, are mainly composed of much altered and highly crystalline volcanic rocks, such as (in the order of their frequency) dolerites, diabases, diorites, gabbros, serpentines, saussuritic felspar rock, etc. It is most probable that the greater number of the seven large islands of the group are mainly composed of these ancient and highly altered volcanic rocks. The Island of Bougainville, however, would

appear to be of more recent volcanic origin. It seems to be formed of a linear series of lofty mountain cones, one of which at least is active at the present day. The smaller islands of volcanic constitution are either mixtures of modern rocks with more ancient and often highly crystalline rocks, or they are composed almost entirely of recently erupted material. In the latter case the islands preserve the volcanic profile, possess craters, and sometimes exhibit signs of latent activity. Pages 8–62 are devoted to the details of these volcanic islands.

That an enormous amount of denudation has affected the Solomon Islands is evident from the laying bare of the deep-seated plutonic rocks before mentioned; and it is also equally certain that this is an area of elevation, by no means remote in time, through a vertical range of some thousands of feet. This is abundantly shown by the various muds and oozes of deep-sea type which now constitute a notable proportion of the land above sea-level—a class of deposit possessing considerable interest for geologists, whilst to those who have been engaged in testing the nature of the ocean floor such rocks afford an opportunity of a comparison of great value. Hitherto there has been little chance of studying the consolidated oceanic muds, since it is pretty well understood by this time that the ordinary formations of continents and continental islands, such as our own, have nothing in common with the oceanic muds and oozes now in course of deposition. It is just possible that the Chalk may be an exception to this rule, but at any rate we have quite enough controversial matter before us without troubling ourselves with this question. The so-called "chalk" of New Ireland is regarded by Mr. Brady as a deep-sea deposit of comparatively recent age, which was probably formed in depths of not less than from 1500 to 2000 fathoms. Then again there is the well-known Suva deposit, or so-called "soapstone" of the Fiji Islands, which has been the subject of a recent communication by Mr. Brady to the Geological Society. Thus glimpses have from time to time been obtained of the nature of the deep-sea deposits, when elevated into dry land, from more than one quarter, and we are therefore prepared to read Mr. Guppy's account of the recent calcareous formations of the Solomon Islands with a considerable amount of interest, not to say of curiosity.

The recent rocks, he says, may be arranged into several groups, commencing with the coral limestone and ending with the deeper deposits. The *first group* includes the coral limestones properly so called, which are mainly composed of the massive corals in different stages of fossilization. The interstices are filled by coral débris, molluscan shells, and the remains of the numerous organisms that live upon the reefs.

The *second group* includes those coral limestones which have the composition of the coral muds and sands that were found by the "Challenger" expedition to be at present forming near coral islands and along shores fringed by coral reefs. They are derived chiefly from the disintegration of the neighbouring reefs, but they receive

large additions from the shells and skeletons of pelagic organisms, as well as from those of animals living at the bottom. Three principal varieties are indicated in this group, which includes the majority of the so-called coral limestones found in the Solomon Islands. The non-calcareous matter, which is small in amount, consists of the common volcanic minerals, and a few glassy fragments, etc. The chalky coral limestones constitute a section of this group; and the consolidated calcareous ooze of the channels, which forms compact fawn-coloured limestones of homogeneous texture, also is referred to this group.

The *third group* comprises a still greater variety of rocks, corresponding in composition to the volcanic muds and pteropod oozes of the "Challenger." These are composed of the *débris* of volcanic rocks mixed with the shells of Foraminifera, Molluscs and many other calcareous organisms. Judging from the Foraminifera they may be regarded as of Post-Tertiary age.

The *fourth group* comprises the foraminiferal limestones, which are grey or yellowish-brown in colour, hard and compact in texture, and are chiefly made up of the tests of pelagic and bottom-living Foraminifers. They usually contain from 70 to 85 per cent. of carbonate of lime, and may be described as the consolidated foraminiferous oozes of the "Challenger" and other expeditions. An interesting description of a *Rhynchonella*-limestone and some valuable remarks relative to the beach sand-rock, which is generally regarded as in some way connected with the formation of oolite, follow, and then comes a detailed description of the several calcareous islands.

Dr. Guppy's descriptions of the calcareous formations of these islands afford, probably, the most complete account we have yet received of the rôle played by the deposits of the deep ocean in the formation of rock-masses; and, at the same time, it is difficult to conceive anything more interesting to geologists, who, if the charter of the Geological Society be accepted literally, are supposed to be desirous of investigating the mineral structure of the earth. This portion of the work is also, in the main free from controversial matter.

It would, however, have been impossible for Dr. Guppy to have ignored the question of the mode of formation of coral reefs, when engaged in the general physical investigation of the Solomon Islands. His conclusions on this point may be summarized as follows:—(1) That the upraised reef masses, whether atoll, barrier, or fringing reef, were formed in a region of elevation; (2) that such upraised reefs are of moderate thickness, their vertical measurement not usually exceeding the usual limit of the depth of the reef-coral zone; (3) that these upraised reef masses in the majority of islands rest on a partially consolidated deposit, which possesses the characters of the "volcanic muds" that were found during the "Challenger" expedition to be forming round volcanic islands; (4), that this deposit envelopes anciently submerged volcanic peaks.

Plans and sections are given in the two accompanying plates, and, if these are to be relied upon, the coral limestones are shown to exist

as little more than a facing or veneer upon the really bulky ooze deposits. Such an arrangement tallies far better with the developments of reef-building coral known to exist in our own islands than the more stupendous thicknesses assigned to reef rock under the subsidence hypothesis. Indeed the author claims that these excessive thicknesses may be altogether hypothetical in the majority of cases. It has, we believe, been no uncommon thing for geologists to overestimate the thickness of beds from various causes. As a familiar instance of this, we may cite the classical section of Assynt, where, according to the interpretation of Sir R. Murchison, a thickness of thousands of feet was assigned to the quartzite-limestone series of Ben More; whereas, if that celebrated geologist had taken the trouble to penetrate into the heart of the mountain, instead of inspecting its flanks alone, he would have found that this imposing and seemingly solid array was merely a casing over the great Archæan masses beneath—a trap, in fact, set by nature to catch those who are in the habit of taking a one-sided view of things.

Naval men of experience are evidently beginning to doubt the sufficiency of the subsidence theory to explain the production of barrier reefs and atolls. This has been made very plain by the notice on Coral Formations from the Hydrographer to the Admiralty which appeared in "Nature" (Feb. 23, 1888). At the same time we must guard ourselves against any unfair imputations which it may be sought to fasten upon the principal author of the subsidence theory, in view of its possible collapse.

That most judicial of all writers took into consideration the majority of the theories which had been advanced in his day, and if he ultimately decided in favour of the subsidence theory, it was more from lack of evidence than from any other cause. But the master is generally surpassed by the disciple in the implicitness of his faith. The latter, fascinated by an explanation which, in this case, has the merit of great ingenuity, and possessed by a natural unwillingness to admit that his wisdom is foolishness, views with suspicion anything likely to compromise his orthodoxy.

Such considerations may possibly help to account for the nervous reluctance of many geologists to accept any explanation of the origin of coral reefs unconnected with or adverse to the subsidence theory. It is perfectly true that Darwin had Dr. Murray's facts and inferences before him, and that he made no sign of change in his views (letter dated 1880, quoted by Mr. Mellard Reade in "Nature," Nov. 17, 1887), nor have we any absolute right to assume that even the remarkable physical history of the Solomon Islands would have induced him to modify them. But no matter how great may be the authority of any one individual, living or dead, if a series of facts, such as those recorded in the work before us, are plainly repugnant to the theory of subsidence in connection with the growth of reef-coral, it is the manifest duty of geologists especially to examine such facts without prejudice, and to be ready to modify their views in accordance with the ever-advancing tide of scientific knowledge.

W. H. H.

IV.—A Sketch of Geological History, being the Natural History of the Earth and of its Pre-Human Inhabitants. By Edward Hull, M.A., LL.D., F.R.S. 8vo. pp. 179. Coloured Sections. (London, 1887.)

IN order that our Science may draw recruits from all types of minds and from all quarters, and that it may exercise due influence on other classes of research, it is necessary that its soundest and most advanced conclusions should occasionally be put before the world in an interesting fashion, in brief and popular books. In the days of Sedgwick and Murchison the science was accounted a hard-walking, hard-working, fighting science, suited for healthy bodies, keen eyes, and deep-thinking minds, while Lyell and Darwin made plain that work could be done by all, whether they had the opportunity of world-girdling travel or could only watch worms in a back garden. We recovered from an era of species-making and minute subdivisions when (though others shared in the researches) Sir A. Ramsay and Professor Hull gave to the reading public a chance of seeing the result of this work in the successive geographical phases through which our own and other areas have passed.

So when the latter author produces "A Sketch of Geological History," part of a series of works on Universal History, evidently intended to be read by a very large section of the public, we have high expectations that even this most abstruse branch of the science will be dressed in its most attractive garb, that we shall find arguments (at least indicated) as well as facts, that all but necessary technicalities will be shelved, and that we shall be presented with a comprehensive view of the inorganic condition of the surface of our planet, and of the organic evolution which took place upon it. One in need of such things turns to the work and alights on this passage:—"The Lamellibranchs were also exceedingly abundant, yielding 1319 species; the most abundant being the genera *Avicula, Gervillia, Gryphæa, Lima, Ostræa, Pecten, Pinna, Plicatula, Arca, Astarte, Cardium, Cypricardia, Gresslya, Leda, Modiola, Myacites, Mytilus, Opis, Pholadomya, Pleuromya,* and *Trigonia*; many of these genera survive in the seas of the present day." Will he close the book in despair? Let us see.

The work opens with a small division on the Consolidation and Cooling of the Globe, and the Plutonic Rocks. Perhaps this was inevitable, but surely the human mind would then hanker after some guiding principle to tell it how to digest the chaotic mass of "clay-slates, conglomerate, quartzite, and limestone," which it is shortly called upon to consume, into some form of nourishing mental pabulum. It needs to be shown in what forms the rocks themselves contain the evidence on which the old physical geography may be restored, but that this evidence is sometimes unattainable because the strata may have been removed by denudation or be covered by subsequent deposits. In the first case some help may be obtained if the strata are conformable by the evidence given by previous and subsequent deposits; if unconformable, by the very nature of the movements which produce the unconformity. In the second case

we are helped by facts gained by deep borings, by the facts of palæontological distribution, and by the nature of earth-movements of preceding periods.

Even if we pass over the extreme difficulty exhibited by the nature of the case in the Archæan and Lower Palæozoic ages, it is difficult to see why the author has said so very little about his favourite Devonian period, so little that even the customary "Position of Sea and Land during the Period" has been omitted. Turning again to the Carboniferous period, Englishmen reading an English book would have liked some reference, not only to the Atlantis, a summary of the arguments for which is given, but to the borders of the continent, whatever it was, on whose edges the deposits so important to our industries were made, and some of whose shore lines have been so well worked out in England. The notice of the wide spread of shells and plants in this period is interesting, but the untrained reader needs to be shown the bearing of this in the increased complexity of the barrier system which guides distribution, introduced by the development of earth-movement as time went on. The author again has been one of the chief to insist on great crust movements some time after the Carboniferous period; should he not have shown us that the development of the Pendle and London ridge, and other E. and W. ranges, and of the Pennine and other N. and S. ranges, must have had some influence on the geography of the succeeding Permian or, at latest, the Triassic periods? As we reach later times, the geography is better worked out, but even here we are not definitely told that while conformable strata furnish the history of submersion, unconformabilities are no less valuable as giving evidence of land surfaces, and, by telling us of movement and mountain building, show us in what direction to look for shore lines; nor do we think the term "conformable hiatus" has any very decided advantage over the older one of deceptive unconformity.

Side by side with rock history we are given an account of the fossils of each formation. The technical student has no need of such lists, and of what use can they be to the general reader? The author, rather late in the work, sets himself an example when he gives a partial sketch of the evolution in the ancestry of the Horse. Ought he not to have shown that the same can be done for some other Mammalia, and to have indicated, throughout the Tertiary period, a tendency to advance from generalized to specialized forms of life? The Dinosaurs and Birds have their proper share of attention in the Mesozoic rocks, but we cannot help thinking that a few words of explanation on the zoological position and affinities of the rest of the Reptiles, of the Amphibians, and the Fish would have been more useful than clouds of names; nor do we think that the bald statement that a species of *Ceratodus* survives in Australian rivers is enough to make of a most significant fact. Could not the author have helped the reader by giving him an inkling as to what a heterocercal tail really meant, and particularly in alluding to the embryonic fish types of the Devonian period? The possibility of an explanation of the sudden appearance of so many forms of life in the Cambrian period

ought hardly to have been passed by. Godwin-Austen's classical memoir might have suggested some points of importance in dealing with the Carboniferous rocks; there is not absolute unanimity amongst geologists as to the abyssal origin of the Chalk, or about the Miocene age of the Bovey lignites; while the height of Moel Tryfaen is generally given as 1360 and not 1170 feet.

The book suffers also from many misprints; there is hardly a fossil list without one; we often have œ for æ, and we meet with *artica, C. elaphas, Rhynconella, Anchyterium, Cristeltaria, Nautali, Archæopterix, Belemintes, E. liliiformiss,* etc. We cannot help closing the work with a feeling of disappointment that a capital opportunity has been missed of presenting to untechnical readers a readable and yet thorough and scientific "Sketch of Geological History."

V.—A Sketch of the Geology and Climate of Hertfordshire. By John Hopkinson, F.L.S., F.G.S., Treas. Geol. Assoc., V.P. Herts Nat. Hist. Soc. (Hertford, printed by Stephen Austin and Sons, 1887.)

THIS is an extract from the Introduction to the "Flora and Fauna of Hertfordshire," by the late R. Pryor, B.A., F.L.S., which now appears in a separate form as a small quarto of 52 pages, together with a coloured map of the county showing its river basins as adopted for the Botanical Districts. The interest is largely meteorological and botanical, but the whole structure is laid on a geological foundation. This part of the subject is illustrated by two maps, the first of which shows the superficial geology—Alluvium, Boulder Clay, Gravel and Sand chiefly Glacial, Brick-earth, Clay with flints and occasionally Brick-earth, Pebble Gravel, and lastly Eocene and Cretaceous. Although, of course, one or other of the two latter underlies the entire surface of the county, both are so largely masked by superficial or "drift" beds that the second, or agricultural, map is mainly influenced by the development of these superficial beds. Doubtless many of these facts are well known to students of the various Memoirs dealing with the London Basin, but Mr. Hopkinson has his own way of telling the story, and he contrives to put a considerable amount of useful matter before his reader within the limits of a very few pages. The chapter on Hydro-geology is especially interesting, and in view of the impending drought may well attract attention. The Botanical Districts would seem to coincide with the river systems. I. Drainage of the Ouse: 1 Cam, 2 Ivel. II. Drainage of the Thames: 3 Thame, 4 Colne, 5 Brent, 6 Lea. The first three are outside the London Basin and together constitute not more, perhaps, than one-eighth of the county.

W. H. H.

VI.—Annuaire Géologique Universel. Revue de Géologie et Paléontologie, dirigée par Dr. L. Carez pour la partie Géologique, et H. Douvillé pour la partie Paléontologique, avec le concours de nombreux Géologues Francais et Étrangers. Publié par le Dr. Dagincourt. Tome III. Paris, 1887. 8vo. 1re partie, Géologie, pp. xxvii. and 777; 2e partie, Paléontologie, pp. vii. and 235.

THIS third volume of the Annuaire Géologique Universel—a massive book of more than a thousand pages—has attained a development far in advance of its two predecessors. It contains a well-arranged Bibliography of the works published on the several different branches of geological science, and a comprehensive review of the geological and palæontological discoveries and work done and in progress in the different countries of the globe during the year 1886. This summary cannot fail to be of material assistance to all students of the science, and we hope it will have the wide circulation which it deserves.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—Annual General Meeting, February 17, 1888.—Prof. J. W. Judd, F.R.S., President, in the Chair.

The Secretaries read the Reports of the Council and of the Library and Museum Committee for the year 1887. The Council stated that they had again to congratulate the Fellows upon the continued prosperity of the Society, although they had to state, with regret, that there was a diminution in the total number of Fellows. The number elected during the year was 46, and the total accession 53; but the losses by death, resignation, etc., amounted to 60, causing an actual decrease of 7 in the number of Fellows. Nevertheless from the large proportion of compounders and non-contributing Fellows deceased, the actual number of contributing Fellows was increased by 7. The balance-sheet showed receipts to the amount of £2760 15*s.* 9*d.*, and an expenditure of £2961 15*s.* 8*d.*, being an excess of expenditure of £200 19*s.* 11*d.*, caused by the expense incurred in the necessary repairs, painting, etc., of the house occupied by the Society; but notwithstanding this and the addition of £250 to the amount of the Society's funded property, the accounts showed a balance in the Society's favour. The Council's report further announced the awards of the various Medals and of the proceeds of the Donation Funds in the gift of the Society.

In presenting the Wollaston Gold Medal to Mr. Henry Benedict Medlicott, M.A., F.R.S., the President addressed him as follows:—

Mr. Medlicott,—The Council of this Society are not unmindful of the fact that many of our Fellows are engaged in the promotion of geological science in every part of a vast empire; in awarding to you the highest honour which is at their disposal, they are following a precedent which was established more than fifty years ago, by the presentation of the Wollaston Medal to Cautley and Falconer. In that great Indian dominion where those famous geologists carried on their important

researches, you commenced your labours as far back as the year 1854; and for more than a third of a century you have continued the almost incessant exertions which have led to very important additions to our knowledge, often obtained only at the price of severe hardships and at the risk of serious dangers. During the last eleven years you have occupied the important and responsible position of Director of the Indian Survey; and it is to your administrative ability in that position that we owe many of the valuable results obtained by that Survey in recent years; more especially are we indebted to you, and to our Secretary, Dr. Blanford, for that useful Compendium of Indian Geology which has now become indispensable to all students of our science. We feel it to be singularly appropriate that we are able to make this award to you just at the time that you return to your native country for the rest you have so well earned.

Mr. Medlicott replied:—Mr. President,—The award of the Wollaston Medal by the Geological Society is the most gratifying distinction that a Geologist can receive. It is only as a recognition of devotion to our Science that I can venture to accept so great an honour. My work has been chiefly in combination with others, and it gives me much consolation to think that my colleagues of the Geological Survey of India will share in this reward and will appreciate it.

In handing the Balance of the Proceeds of the Wollaston Donation Fund to Archibald Geikie, LL.D., F.R.S., for transmission to Mr. John Horne, F.G.S., the President addressed him as follows:—

Dr. Geikie,—The Council of the Geological Society being desirous of aiding Mr. John Horne in carrying on his important investigations in the Volcanic and Glacial geology of the northern part of our islands, have awarded to him the Wollaston Fund for the present year. Seeing that in their researches Messrs. Peach and Horne have been so constantly united, it was felt that in the recognition of their services to science they ought not to be divided; in the roll of honour containing the names of those who have received this award the name of Mr. Horne will appropriately follow that of his friend. In transmitting this award to our fellow-worker, will you express the hope that it may be of some service to him in enabling him to continue those studies which have already done so much towards elucidating the structure of the land of his birth?

Dr. Geikie, in reply, said:—Mr. President,—At the request of my friend and colleague, Mr. Horne, I have much pleasure in receiving for him the Wollaston Fund, and in conveying to the Society his cordial thanks for this mark of its appreciation. If anything could add to the pleasure with which he receives this prize, it would be the association with his friend and companion in geological labour, Mr. Peach, to which you have alluded. A member of the Geological Survey, placed in a distant and inaccessible region, has need of all the enthusiasm of his nature when he has to combat with great and difficult geological problems amid the lesser troubles of hard fare, poor lodging, and the absence of all those sympathies of human intercourse which so help us in our pursuits. To such a far off and, as it were, forsaken brother there can come no greater encouragement and stimulant than recognition of his labours from those who stand nearer to the central pulse of life in the country. Mr. Horne is so enthusiastic in the discharge of his official duties and in the cause of science as sometimes to risk his health by prolonged exposure to the inclemencies of the boisterous north. In this award he feels that his work, remote though its area may be, has not escaped the friendly notice of the Geological Society of London, and that it encourages him to give himself as heartily in the future as in the past to the advancement of the science to which we are all devoted.

The President then handed the Murchison Medal to Archibald Geikie, LL.D., F.G.S., for transmission to Prof. J. S. Newberry, M.D., F.M.G.S., and said:—

Dr. Geikie,—The Council of this Society in awarding the Murchison Medal to Dr. Newberry, desire to place on record their sense of the very high value of his geological researches in various parts of the United States. Dr. Newberry's studies have been pursued, during the last thirty years, in connexion with every branch of Geological Science. The maps and memoirs of the Geological Survey of Ohio afford the highest proofs of his skill as a stratigraphical geologist; numerous papers dealing with the phenomena of the Glacial Formations testify to the attention which he has

devoted to that important subject; while several of his memoirs treat of petrographical questions. In Palæontology Dr. Newberry has made many valuable contributions to our knowledge, especially in connexion with Fishes and Plants. Nor have the great problems of Geological Philosophy been neglected by our esteemed Foreign Member, who now occupies so important a post in connexion with one of the greatest educational institutions of his native country. When the Director-General of our own Geological Survey transmits to one of the pioneers of American Geology a medal founded by a father of British Geology, the action may be fairly held to typify the universal brotherhood of Science.

Dr. GEIKIE, in reply, said:—Mr. President,—On the part of Dr. Newberry I am commissioned to receive the Murchison Medal which has been awarded to him. Were my friend here himself, he would express, far more fittingly than I can, his gratification that the Geological Society of London has conferred this honour upon him. But there is one advantage perhaps in his absence, that we can freely speak of him and his work, regarding which he would himself wish to be silent; and it is of him and his work that the Fellows doubtless wish to hear.

It is now nearly forty years since he began his scientific career. During this long interval of constant and enthusiastic labour, as you have so well observed, there are few departments of Geology into which he has not entered, and where he has not left the impress of his clear insight, his singular mastery of detail, and his faculty of broad and luminous generalization. And yet this record of fruitful work has been achieved in the midst of continual demands on his time and thought made by professional and official duties—demands which for most men would have been enough to fill up a busy life. To geologists on this side of the Atlantic who know him only by published writings, there are more especially three lines of research with which his name is associated. It was he who in the expedition under Lieutenant Ives, eight-and-twenty years ago, first made known to the world the wonders of the Colorado River of the West, who recognized in that region monuments of the most stupendous denudation, and who by his clear and graphic descriptions inaugurated a new era in the discussion of the problem of land-sculpture. His researches on Fossil Plants have placed him in the very front rank of those who have made known to us the characters of the vegetation of former periods of the earth's history. As a fitting crown to these researches he will shortly publish a large monograph, with two hundred plates, descriptive of the fossil floras of North America. And, thirdly, his long and minute investigation of Fossil Fishes has enabled him to repeople the ancient waters of the North American continent with the abundant and often extraordinary types which characterized them. Another great monograph, with sixty plates, on this subject, is also in the press.

There seems to me something peculiarly appropriate in the award of the Murchison Medal to such a man. He is a geologist after Murchison's own heart—keen of eye, stout of limb, with a due sense of the value of detail, but with a breadth of vision that keeps detail in due subordination.

If I may be permitted, I would fain add a word of personal gratification that it has fallen to my lot to be intermediary on this interesting occasion between the Geological Society of London and one of the most distinguished men of science in the United States. The geologists of North America are drawn to us by stronger ties and closer sympathy than most of us are perhaps aware. They look on our Society as the parent of their own kindred associations. Our fathers in geology are also theirs. They wait for the advent of our Journal, and keep themselves far more fully conversant with what is done within these walls than most of us, I am afraid, do with their work. I confess that, for myself, I often feel ashamed and mortified that I can do so little to keep myself abreast of the rapid and astounding progress of our science on the other side of the ocean. We hardly realize and recognize as fully as we should the nature and bearing of the work of our brethren across the sea. So I hail this opportunity of holding out the right hand of fellowship, for I am certain that the geologists of the United States will feel that in doing honour to Dr. Newberry the Geological Society of London wishes at the same time to express its appreciation of American geologists and its best wishes for the advance of American geology.

In handing the Balance of the Proceeds of the Murchison Geological Fund to Henry Woodward, LL.D., F.R.S., for transmission to

to Mr. Edward Wilson, F.G.S., the President addressed him as follows:—

Dr. Woodward,—The Council of this Society, being desirous of marking their sense of the great value of Mr. Edward Wilson's geological investigations, have awarded to him the Balance of the Murchison Fund for the present year. Both at Nottingham and at Bristol Mr. Wilson has shown his ability as a careful observer and trustworthy exponent of the stratigraphy of the surrounding country; and it is our hope that this award may afford him both encouragement and assistance in continuing those important researches in fields of study where he has already laboured with such devotion and success.

Dr. Woodward, in reply, said:—Mr. President,—Mr. Edward Wilson is, I am happy to say, only one out of a large number of local geologists (many of whom are Fellows of this Society) all doing good work and all deserving of recognition, were it possible to extend to many more the same expression of approbation of their labours. Such assistance affords to them facilities for travel or for the acquisition of books for carrying on their work.

These are only a few of the trivial advantages; but *the highest of all* is the sense of recognition which this Society's Award gives to such solitary workers, who are often without any local support or encouragement for their efforts. Mr. Edward Wilson's published work dates back to 1868, and is represented by more than 12 papers, dealing mostly with the Red Marls, Keuper and Bunter Beds, the Rhætic and the Lias, one of his latest papers being on the Liassic Gasteropoda with descriptions and figures of 14 species.

Dr. Woodward further read the following communication from Mr. Wilson:—"Will you kindly convey to the President and Council my grateful sense of the honour which they have conferred upon me? At the same time would you please express my regret at not being able to be present on this occasion?

"Notwithstanding the progress which has been made in our knowledge of the late Palæozoic and early Secondary Rocks, since the illustrious Murchison established his Permian system, now nearly fifty years ago, a great deal remains to be accomplished in this special department of British geology. In several districts the true ages of the "Red Rocks"—whether Permian, or Trias, or Carboniferous, or even Old Red Sandstone—have yet to be determined. Of the many other interesting matters relating to these rocks which require further elucidation, one of the most important perhaps is the question of the extension of the older rocks, and in particular of productive Coal-measures, beneath the newer formations. In the above field of Geology, then, there is scope for plenty of good work in the future, and it is in this field that my highest ambition would be to contribute some useful result."

In presenting the Lyell Medal to Prof. H. Alleyne Nicholson, M.D., F.G.S., the President addressed him as follows:—

Prof. Nicholson,—The Lyell Medal has been awarded to you as a mark of appreciation of your valuable researches among the older Palæozoic rocks, both in the Old and New World, and of your continued and patient investigations into the organization of some of the obscurer forms of life which abounded at the period of the deposition of those rocks. Your researches among the Graptolitidæ, the Stromatoporidæ, the Monticuliporidæ, and the Tabulate Corals have given you a high place among palæontologists; while the difficulties which surround such studies as those you have undertaken are so great that geologists may well feel admiration for the courage and perseverance which you have shown in steadily devoting yourself to the study of such seemingly unpromising materials. The bequest of Lyell could certainly not be more appropriately bestowed than in recognition of labours like your own, which have been especially directed to a comparison of the fossil faunas of Britain and North America.

Prof. Nicholson, in reply, said:—Mr. President,—It would not be easy for me to adequately express my grateful sense of the very high honour which has been conferred upon me by the Council and Fellows of the Society in awarding to me the Lyell Medal. In common with all British workers, I regard the Geological Society of London as the supreme head and source of honour in matters connected with Geology and Palæontology. Under any circumstances, therefore, I should have deeply valued the distinction which I have to-day received, the more so that it is

associated with the name of one whose memory will ever be honoured by students of Geological science. To a very special degree, however, and in a very special sense—a sense only to be fully comprehended by those similarly placed—is there a gratification and a stimulus in such an award to a worker so unfortunately isolated by his geographical position as it is my lot to be, and with such limited opportunities of coming in contact with his fellow-workers. The pleasure I have felt has been enhanced by the friendly words of encouragement and approbation in which you, Mr. President, have seen fit to speak of my past work. If I cannot feel that I have sufficiently deserved, by anything I have yet been able to accomplish, the high honour I have to-day received, I can assure the Council and Fellows that I shall do what in me lies to make myself more fully worthy of it in the future.

The President then presented one moiety of the Balance of the Proceeds of the Lyell Geological Fund to Mr. Arthur Humphreys Foord, F.G.S., and addressed him in the following terms:—

Mr. Foord,—Your skill with the microscope and pencil have stood you in good stead in investigating and illustrating the minute structures of many wonderful fossils from the older rock-masses of our globe. To our knowledge of some of these remarkable organisms, which alike from their aberrant characters and from the very remote period at which they lived, must ever have the greatest fascination both for Geologists and Biologists, you have made some very valuable contributions; and the Council of this Society trust that an Award from the Lyell Fund will serve as a stimulus and aid to you in carrying on these and kindred researches.

Mr. Foord, in reply, said:—Mr. President,—I beg to return my warmest thanks to the Council of the Geological Society for this most acceptable and quite unlooked-for mark of their approval of the slight services I may have rendered to Geological Science. While the gift itself will afford me material aid in the further prosecution of my palæontological studies, the thought that I have been deemed worthy of such a great distinction will add a new impulse to those labours.

The President next presented the second moiety of the Balance of the Proceeds of the Lyell Geological Fund to Mr. Thomas Roberts, F.G.S., and addressed him as follows:—

Mr. Roberts,—Among the most valuable methods for solving the great problems of stratigraphical geology is the one which has been chosen by yourself, namely, the direct comparison of a series of beds and of their characteristic fossils in one typical district with those of another and now isolated area. The Council of the Geological Society, hoping to encourage you in work of this kind, so well begun, have awarded you a portion of the Fund bequeathed to us by one who was among the first to recognize the value, and to pursue with success that method of research in which you are now engaged.

Mr. Roberts, in reply, said:—Mr. President and Gentlemen,—I beg to express my grateful acknowledgment of the honour the Council of the Geological Society have conferred upon me by the award of the moiety of the Lyell Fund. It is especially gratifying to me to find that the small contributions which I have hitherto been able to make to the Society have been thought worthy of recognition. In making the award the Council seem also to have taken into account the work involved in teaching others, and thus preparing myself for that accurate observation which is the first essential in Palæontological research.

It will stimulate me to further exertions; for there is still much to be done in the correlation of our Jurassic rocks as well as in other branches suggested to me by the rich collection in the Woodwardian Museum.

I hope, from time to time, to offer to the Society further contributions, and I shall be proud and pleased to co-operate with other workers in the same field, and to assist them in availing themselves of the magnificent collection in the Museum with which I am officially connected.

The President then read his Anniversary Address, in which, after giving obituary notices of Mr. Champernowne, the Rev. W. S. Symonds, Sir Julius von Haast, Mr. Robert Bell, and other deceased Fellows, together with notices of the Foreign Members and Correspondents of the Society who died during 1887—Studer, de Koninck, Desnoyers,

Hayden and Count Marschall,—he proceeded to congratulate the Society upon its flourishing condition, alike as regards its numbers, its finances, and the work which it has accomplished during the past year. The remainder of the Address was devoted to a discussion of the relations which exist between Geology and the Biological sciences. He insisted on the maintenance of Palæontology as a distinct branch of science, having equal claims upon the attention of Geologists and Biologists, and he instanced the life and work of Charles Darwin, as exemplifying the value and importance of a combination of Geological and Biological research.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President*: W. T. Blanford, LL.D., F.R.S. *Vice-Presidents*: John Evans, D.C.L., LL.D., F.R.S.; Prof. T. M'Kenny Hughes, M.A.; Prof. J. Prestwich, M.A., F.R.S.; Henry Woodward, LL.D., F.R.S. *Secretaries*: W. H. Hudleston, Esq., M.A., F.R.S.; J. E. Marr, Esq., M.A. *Foreign Secretary*: Sir Warington W. Smyth, M.A., F.R.S. *Treasurer*: Prof. T. Wiltshire, M.A., F.L.S. *Council*: W. T. Blanford, LL.D., F.R.S.; John Evans, D.C.L., LL.D., F.R.S.; L. Fletcher, Esq., M.A.; A. Geikie, LL.D., F.R.S.; Henry Hicks, M.D., F.R.S.; Rev. Edwin Hill, M.A.; W. H. Hudleston, Esq., M.A., F.R.S.; J. W. Hulke, Esq., F.R.S.; Prof. T. M'Kenny Hughes, M.A.; Prof. T. Rupert Jones, F.R.S.; Prof. J. W. Judd, F.R.S.; R. Lydekker, Esq., B.A.; Lieut.-Col. C. A. McMahon; J. E. Marr, Esq., M.A.; E. T. Newton, Esq.; Prof. J. Prestwich, M.A., F.R.S.; Prof. H. G. Seeley, F.R.S.; Sir Warington W. Smyth, M.A., F.R.S.; W. Topley, Esq.; Rev. G. F. Whidborne, M.A.; Prof. T. Wiltshire, M.A., F.L.S.; Rev. H. H. Winwood, M.A.; Henry Woodward, LL.D., F.R.S.

II.—Feb. 29, 1888.—W. T. Blanford, LL.D., F.R.S., President, in the Chair.—The following communications were read:—

1. "An Estimate of Post-Glacial Time." By T. Mellard Reade, Esq., C.E., F.G.S.

The author showed that there exists on the coasts of Lancashire and Cheshire an important series of Post-Glacial deposits which he has studied for many years. The whole country to which his notes refer was formerly covered with a mantle of low-level marine Boulder-clay and Sands, and the valleys of the Dee, Mersey, and Ribble were at one time filled with these glacial deposits.

These glacial beds have been much denuded, especially in the valleys, where the rivers have cleared them out, in some cases, to the bed rock. Most of this denudation occurred during a period of elevation succeeding the deposition of the Low-level Boulder-clay. On this eroded surface and in the eroded channels lie a series of Post-Glacial beds of a most interesting and extensive nature. They consist of estuarine silt and *Scrobicularia*-clay covered by extensive peat-deposits, containing the stools of trees rooted into them. Upon these lie, in some places, recent tidal silts, and on the coast margin blown sand and sand dunes. The series of events represented by the denudation of the Low-level Boulder-clay and the laying down of these deposits is as follows:—1st, elevation succeeding the glacial period, during which time the Boulder-clay was deeply denuded in the valleys. 2nd, subsidence to about the 25-feet contour, when the estuarine silts and clays were laid down. 3rd, re-elevation representing most probably a continental connexion with the British

Isles, during which time the climate was milder than at present, and big trees flourished where now they will not grow. 4th, subsidence to the present level, the submersion of the peat and forest-beds, the laying down of tidal silt upon them, and the accumulation of blown sand along the sea-margin extending to a considerable distance in an inland direction.

It was estimated, from a variety of considerations, that these events, all posterior to the Glacial period, represent a lapse of time of not less than 57,500 years allotted as follows:—40,000 years for the elevation succeeding the Glacial period measured by the denudation of the Boulder-clay in the valleys, 15,000 years for the accumulation of the estuarine silts, clays, peat, and forest beds, and 2500 years for the blown sand.

2. "Note on the Movement of Scree-Material." By Charles Davison, Esq., M.A. Communicated by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

The author noticed the frequent high angle of slope of screes, and called attention to Canon Moseley's observations on the downward creep of lead on the roof of Bristol Cathedral, and his subsequent experiment, and stated his belief that stones free to move on the surface of a scree must be affected in the same manner. This he proved by experiments, the result of which he described.

These experiments showed that stones do move downwards, owing to alternate contraction and expansion, the movements accompanying or occurring a short time after the change of temperature, that the descent is greatest on days of bright sunshine interrupted frequently by passing clouds, and that rain slightly increases the rate of descent.

A description was given of a scree on Hindscarth, Cumberland, in which the stones lie with their longer axes pointing down the slope; and it was pointed out that the movement of the stones in the way described would cause the surface-stones to fall off those on which they rested, and that others would be dislodged during their descent. A numerical estimate was then made of the total amount of movement produced on a scree of a certain size by expansion and contraction of the surface-stones, and after alluding to the relative efficiency of this and other agents upon various screes, the author concluded by pointing out that in the case of the moon this might be almost the only agent at work.

3. "On some Additional Occurrences of Tachylyte." By Grenville A. J. Cole, Esq., F.G.S.

An intrusive sheet, some eight feet thick, among the basalts of Ardtun Head in Mull, has selvages of tachylyte. The specific gravity of the glass is 2·83, and in other respects it resembles the examples already described from the west of Scotland. But in thin section, numerous fairly translucent spherulites are seen, which accumulate towards the inner part of the selvage until the glassy material between them disappears, and they become polygonal by contact. The rays of these spherulites are often alternately grouped in brown or greyer bundles, both series exhibiting striking pleochroism; but the brown fibres appear darkest when their longer

axes are parallel to the shorter diagonal of the Nicol's prism, while the greyish and less fibrous areas are darkest in the reverse position. The author believes that two distinct minerals are present, as in the spherulites of the ordinary granophyric structure; the browner rays may be pyroxenic, but the crystalline substances produced under these conditions of hurried consolidation may be far different from those developed in the more central portions of the mass. Spherulites with pleochroic rays are the normal type in basic glasses, and some occur even in some acid examples.

An analysis of the Ardtun spherulitic tachylyte shows it to resemble that of Beal in Skye, having 53 per cent. of silica and nearly 6 per cent. of alkalies.

An occurrence of tachylyte at Kilmelfort, Argyll, was noted, and a description given of an example of great beauty from the Quiraing in Skye. The latter rock shows, in section, a light-brown translucent glass, with abundant cumulites and small brown spherulites with radial structures.

Near Bryansford, County Down, in Ireland, a basalt dyke occurs, the selvage of which must must have originally resembled tachylyte of the Quiraing. The alteration that this glass has undergone guides one in the search for tachylytes (palagonite and so forth) among the Palæozoic rocks of the British Isles, and an instance was described from Snead, near Bishop's Castle, where fragments of basic glass are imbedded in a tuff of Ordovician age.

In conclusion, the well-known variolite of the Durance was cited as a rock of basic character, comparable, in its perlitic and spherulitic structures, with the acid "pyromerides," both types having alike suffered from secondary devitrification.

4. "Appendix to Mr. A. T. Metcalfe's paper 'On Further Discoveries of Vertebrate Remains in the Triassic Strata of the South Coast of Devonshire, between Budleigh Salterton and Sidmouth.'" By H. J. Carter, Esq., F.R.S. Communicated by A. T. Metcalfe, Esq., F.G.S.

A microscopic examination of certain calcareous pellet-like bodies, containing plates possessing a bony structure, and referred to in Mr. Metcalfe's paper in the Society's Journal for May, 1884, revealed the fact that the plates resembled the scales of the Bony Pike, and also the scales contained in certain Liassic coprolites which were identical in appearance with the Triassic pellets. The author concluded that the latter were the coprolites of Triassic amphibians which fed upon the same kind of Ganoid fishes as did the Ichthyosaurs of the Lias.

The author had also examined microscopically the so-called "spine," No. 1, fig. 2, and the jawbone, No. 2, of Mr. Metcalfe's paper, and observed that there appeared to be no difference between the structure of the latter and that of reptilian bones, whilst its structure is different from that of the Lepidostean scale; with regard to the former, he stated that it was totally different from the spines of two species of *Hybodus* examined, and considered that there were no grounds for considering it a spine.

III.—March 14, 1888.—W. T. Blanford, LL.D., F.R.S., President, in the Chair.

The President announced that it is proposed to build, in memory of the late Mr. Champernowne, a moderate-sized cottage hospital in Totnes. Mr. Champernowne was greatly interested in a temporary hospital, erected in 1885, and was anxious that a permanent institution should be established for the same purpose. The cost is estimated at about £900 or £1000, of which between £500 and £600 have been subscribed in sums varying from a few shillings upwards. Fellows of the Society wishing to contribute to this memorial should send at once to Dr. Currie, Bridgetown, Totnes, Devonshire, or to Archibald Geikie, Esq., F.R.S., 28, Jermyn Street, S.W.

The following communications were read :—

1. "On the Gneissic Rocks off the Lizard." By Howard Fox, Esq., F.G.S., with Notes on Specimens by J. J. H. Teall, Esq., F.G.S.

The rocks may be classed under three heads :—(i.) the coarse gneisses of Mên Hyr type, (ii.) the light-banded granulitic gneisses or Wiltshire type, and (iii.) the transition micaceous rocks of "Labham Reefs," type intermediate between (ii.) and the mainland schists.

The first are seen in Mulvin, Taylor's Rock, Man-of-war Rocks, the Stags, Men Par, Dlidgas, Mên Hyr, and Vasiler; the second in Sanspareil, the Quadrant, and adjoining reefs, Labham Rocks, etc.; and the third in the Labham Reefs.

The inclination of the divisional planes appeared conformable with that of the rocks of the mainland.

The genisses and granulites of several of the islands are traversed by numerous dykes of porphyritic basic rock, seen in Taylor's Rock, Man-of-war Rocks, Sanspareil, Quadrant Rock and Shoals, and Clidgas. These dykes have been disturbed by movements subsequent to their intrusion. They sometimes strike across the foliation-planes of the gneiss and send veins into the latter rock; at other times the strike is parallel to that of the foliation-planes; the two modes of occurrence are occasionally observable in different portions of the course of the same dyke, *e.g.* in one traversing that part of the Man-of-war group known as the Spire. This dyke is also noticeable from the fact that it appears to be traversed by veins of gneiss.

The dykes vary in width from 18 inches to several feet.

In his notes on the specimens Mr. Teall says that the rocks may be arranged in four groups :—

1. Principally occurring in the outer islands, are of the Mên Hyr type, consisting of felspar, quartz, dark mica, and hornblende; the quartz and felspar sometimes exhibit relations characteristic of igneous rocks, at other times they form a fine-grained granulitic aggregate, the latter being probably the result of dynamic metamorphism. This granulation is carried to a greater extent in some of the islands, as in Taylor's Rock. The rocks possess the mineralogical composition of quartz diorite, and may be termed tonalite-gneisses; they may originally have been eruptive tonalites.

2. Occurring chiefly in the inner islands, are of the nature of granulitic gneisses and granulites, confining the latter term to rocks in which the quartz and felspar are present wholly in the form of a micro-crystalline mosaic of fairly uniform grain. In some of these foliation is not well marked. Such rocks occur in "Wiltshire," etc.

3. Rocks showing a passage from the granulitic rocks to the mica-schists of the mainland, as the brown schistose rocks of Labham Reefs. The Enoch rock, a coarse quartzless hornblende schist, also has affinities with the mainland schists.

4. Dykes traversing the gneisses, consisting of porphyritic felspars lying in a ground-mass of hornblende and granulitic felspar. The hornblende is probably secondary after augite, and the rocks epidiorites. These dykes have been affected by deformation, and sometimes pass into actinolite schists near the junction with the gneissose rocks.

In conclusion, the period of dynamic metamorphism, of which the most striking results are seen in the schists of the south-western portion of the Lizard peninsula, was posterior to the formation of the basic dykes. There is no evidence of igneous action in this district since the period of metamorphism.

2. "The Monian System." By the Rev. J. F. Blake, M.A., F.G.S.

The object of the author was to show that the whole of the rocks which, under various names, had been described as Pre-Cambrian in Anglesey, constitute a single well-characterized system, of which the various divisions hitherto described are integral and inseparable parts.

The evidence of these rocks being Pre-Cambrian was first discussed, and it was shown that the greater part of it went no further than to prove them Pre-Ordovician, the basal conglomerates being associated with rocks of Arenig age, though from the occurrence of these conglomerates on Holyhead Island it was inferred that the previous denudation had been great. The rocks of the eastern district, however, are proved to be Pre-Cambrian from the basal Cambrian rocks of Bangor type lying on them unconformably near Beaumaris and near Redwharf Bay. The rocks described are found in six distinct districts in Anglesey.

1. *The Western District.*—The lowest rocks are the great quartzites of Holyhead, which pass at Porth-yr-ogof and inland into chloritic schists, which are foliated in planes of lamination, and thus is produced a tough rock which will not cleave or break, but bends into minute contortions. Towards the east this becomes finer in grain, and may be distinguished as chloritoid schist. On the side of the Straits near the valley it may be seen passing into purple slate. Further north the rocks are confused, especially at Porth-y-defaid, but there is no well-defined fault. The material becomes irregular and forms rocks described as "marbled slate," "lenticular perlites," and soft tuffs. Amongst such are found two special features, viz. masses of quartz in the form of knobs, and lenticular patches of limestone. These it is suggested were produced by the agency of springs rising through and into the ashy rocks. They are especially characteristic of this part of the series. The granite of Pen-bryn-

yr-Eglwys is intrusive, and its junction may be seen in several places, the surrounding rocks developing mica. It is here therefore the youngest rock.

On the south-west side of a fault in Holyhead Island and the neighbouring mainland occurs a distinct group of rocks, continuous upwards from the chloritoid schists, and equivalent to the volcanic facies of the north. These are called the South Stack series. They are characteristically bedded, thrown into large folds, sporadically cleaved, and possess cleavage-foliation. They contain great beds of quartzite, and others of light dusty material. When not cleaved, they are almost entirely unaltered.

The spot near Tywyn, supposed to show fragments of granite contained in a rock of the upper series, and hence the conformity of the two, shows only an intrusive diabase which has caught up granitic fragments.

2. *The Central District.*—This is divided into two parts by a fault. That on the east consists of grey gneiss, considered to be the lowest rock of the whole series, with the quartzite at Bodofon as an episode, followed after a fault by chloritoid schists, so intimately connected with the overlying volcanic facies as to be inseparable. The principal features of the latter are the agglomerates of Llangefni, the quartz knobs, and the more or less bedded sporadic limestones. The portion on the west consists of ashes and fine hälleflintas, together with gneissose rocks of no great similarity to the grey gneiss. These have been so interfered with by intrusive rocks that it is difficult to ascertain their true original character. These intrusions consist of (1) Diorite, often foliated, with the folia contorted, and affording by its brecciation some portion of the surrounding rocks. (2) Granite, seen everywhere to be either intrusive, as at Porth-y-dee, Ceryg-defaid, Craig-y-allor, and Maen-wyn, or absorptive, as near Llyn-faelog. This granite is of various kinds, often passing into a felsite.

3. *The District west of Traeth Dulas* shows granite intrusive into grey gneiss, and also passing into a felsite; it is correlated with the western half of the central district, of which it appears to be a continuation.

4. *The Eastern District.*—The lowest portion here is the grey gneiss, which is very compact towards the west, especially near the igneous rocks, but becomes more micaceous and chloritic towards the east, passing through chloritoid rocks into others of the volcanic facies, with the usual quartz knobs and sporadic limestones, but here, on the whole, more slaty. The complete unity of the whole system is here well seen. The most remarkable feature is the intrusive foliated diorites, which are coarse and non-foliated near Holland Arms, but became finer towards the east, where also glaucophane takes the place of hornblende. They are seen intruding into and contorting the grey gneiss in the Llangaffo cutting.

At the southern end at Careg-gwladys is a remarkable volcanic group, with a spherulitic diabase breaking into and surrounding the baked blocks of calcareous slate. There are associated great masses

of mixed agglomerate, and terminated masses of limestone and quartzite filled with brecciated fragments.

5. *The Northern District.*—This commences in the south with the chloritic schists, but soon becomes slaty, and such rocks with grits occupy the greater part of the area. But towards the north we reach the volcanic facies, characterized as usual by ashes, agglomerates, quartz knobs, in one place near Bull Bay, seen to cross the bedding, and sporadic limestones at Llanbadrig, showing oolite within oolite, and suggesting its origin by a petrifying spring. Above the quartz is found a great conglomerate, apparently derived from it, and immediately above this conglomerate occur the fossils discovered by Prof. Hughes, and no line of separation can be discovered between them and the rest of the rocks in the district. These fossils have been referred to Bala species, and there are three alternatives to choose: either (1) they are not Bala fossils, but are characteristic of the Pre-Cambrian rocks; or (2) they are Bala fossils, and the dividing line has as yet been missed; or (3) there is no dividing line, and the whole series is of Bala age. Against the latter is their similarity to the rocks of the eastern district definitely overlain by Cambrian; and against both the two latter is the fact that the series is unconformably overlain in the neighbourhood by other conglomerates succeeded by black shales in which Llandeilo Graptolites have been recorded.

6. *The District north-east of Parys mountain* is a volcanic complex, in which granite and felsitic rocks with others of a more basic character are inextricably mixed with the débris of the same materials, and both are altered so as to be, in most places, inseparable. This is connected on the N.W. side with grey gneiss.

In the *Lleyn* the rocks belong to the volcanic facies, in which great masses of quartz-felsite, foliated at the edges, are intruded. Here also are found the quartz knobs and sporadic limestones as well as diabase-flows. At Mynydd ystum is found an isolated patch of grey gneiss.

The area between Bangor and Caernarvon has lately been shown to contain some felsite-flows, and also granites, apparently intrusive into ashes, which may belong to the volcanic facies.

At *Howth*, near Dublin, the rocks have all the characters of the South-Stack series, to which they may be correlated; and these are followed upwards by the well-known Bray-Head rocks, which differ from them in character, but whose fossils are not of Cambrian species.

The succession thus shown in the various districts consists of the following in ascending order. The grey gneiss, becoming more quartzose, micaceous, or chloritic in parts, and so representing the quartzite and the chloritic schists of other districts; changing through chloritoid schists into two facies, viz. (1) the slaty, represented best in the northern district, and also as the South-Stack series; and (2) the volcanic facies. No further deposits are recognized in the areas of the volcanic facies, but in the slaty area of Howth the Bray-Head rocks succeed.

To the whole system of rocks the name of Monian is applied, as

derived from Mona, or the Isle of Anglesey, and the several parts are distinguished as the *Holyhead group*, or Lower Monian, the *St. David's group* and the equivalent of the *South-Stack Series*, or Middle Monian, and the *Bray-Head group*, or Upper Monian.

The "Pebidian" represents the St. David's group, and but for its termination, which indicates a system, might be used as an alternative. The "Dimetian and Arvonian" are intrusive granites, or felsitic flows associated with the same group.

The Monian system, though much metamorphosed in its lowest parts, is not considered Archæan, but as a lower sedimentary system than the Cambrian, and hence the lowest system of our ordinary stratified rocks.

CORRESPONDENCE.

THE CAUSES OF THE GLACIAL AND MILD PERIODS.

Sir,—There is a theory on the above subject (due to M. Poisson, I believe) which seems to me worthy of more attention than it has recently received from geologists, viz. that the earth with the entire solar system has travelled through hotter and colder regions of space at different periods. Hotter and colder regions of course mean regions in which it received more or less heat from the stars.

Now that the solar system is moving with considerable velocity through space may be regarded as an established fact, and though it may not have materially changed its position among the stars in historical time, it is otherwise with regard to the much longer geological periods. Mr. Maxwell Hall indeed recently computed that the solar system is moving round a distant centre in a period of 13 or 14 millions of years, though his data I think must be regarded as uncertain. Further, every astronomer knows that there are richer and poorer regions among the stars, the passage of the solar system through which would materially affect the amount of stellar heat.

But it may be thought that the total amount of stellar heat is insignificant compared with solar heat. The observations of Pouillet and Herschel however point to an opposite conclusion. The mean temperature of the earth is more than 500° F. above the absolute zero, of which according to them not more than 300° F. is due to solar radiation. The remaining 200° F. must be ascribed to the heat of the stars. An increase or diminution of 10 per cent. in this would raise or lower the mean temperature of the earth by 20° F., and such an increase confined to the Northern sky would make the North hemisphere 20° F. hotter than the Southern.

I am aware that the results arrived at by Pouillet and Herschel are doubted by many. Further experiments on the same subject by skilled physicists are much to be desired. And should these experiments result in showing that the total amount of stellar heat is insignificant, this fact would not be altogether favourable to the theory of Dr. Croll. If the solar heat is competent to raise the mean temperature of the earth by 500° F. instead of 300° F., the

increase of $\frac{1}{300}$ which takes place at the maximum eccentricity is competent to raise the mean temperature of the earth by nearly 2° F.; and this increase of heat being maintained for thousands of years could not fail to affect the position of the lines of perpetual snow. Whether there would be an actual increase of 2° F. in the mean temperature I need not discuss, because as regards the formation and dissipation of snow and ice the essential element appears to be the quantity of heat absorbed in the course of the year.

13, Belvedere Place, Dublin, *Feb.* 27. W. H. L. Monck.

ON THE CORRELATION OF THE GRÈS DE BELLEU WITH THE LOWER BAGSHOT.

Sir,—In discussing Prof. Prestwich's new correlation of our Eocenes, I could not help calling attention to the fact that while in his table the position of the Grès du Soissonnais would be below the London Clay, its Flora coincided with that of our Lower Bagshot at Alum Bay, above the London Clay. This apparent anomaly is capable of explanation.

The only comprehensive publication on the Flora of the Paris Basin is by Watelet, and though his determinations possess little interest, the illustrations are sufficient in most cases for comparison. The plants represented therein are mainly from Sézanne and Belleu, with a few from other localities. The precise age of the *travertins* of Sézanne is, in the absence of direct stratigraphical evidence, an unsolved problem, but the aspect of its flora is so ancient that it is difficult not to agree with Saporta, Schimper and others who place it in the Pal-eocene. It is in fact allied rather to the newest Cretaceous floras of Europe than to any Eocene flora, and its nearest representative in our country is the flora of Ardtun in Mull. The few plants from the *Grès "intercalés dans les Sables de Bracheux"* and from the Lignites are insufficient to tell us anything, but those from the *Calcaire Grossier* are well-marked Bournemouth species. It is with the vast majority, however, from the *Grès de Belleu*, that we have to deal, and these we cannot hesitate in correlating with our Lower Bagshot of Alum Bay. The forms common to the two are a Fern, the Palms, all those highly characteristic forms called *Comptonia* and *Dryandra*, the large *Ficus Bowerbankii* and other species of *Ficus*, *Laurus*? *Salteri*, *Quercus* or *Castanea eocenica*, a supposed *Cinnamomum Larteti*, the flower called *Porana*, leaves of *Acer*, and bean-pods of *Acacia* and *Cæsalpinia*. The *Podocarpus elegans*, *Marattia Hookeri*, and particularly the *Aralia primigenia*, so characteristic of Alum Bay, are absent, but the two former are equally absent in the corresponding beds so close at hand as Studland. On the other hand, the Belleu beds are far richer in the trinerved leaves known as *Daphnogene* and *Cinnamomum*. Such differences are, however, always met with in separate patches of plants, even if on precisely one horizon and near each other, and do not suffice to affect the main fact, that the facies of the floras is as a whole the same, and very different indeed to any flora above or below them. I have had large series of the plants from both

localities pass through my hands, and the similarity is beyond all question. Now these plants are found in the Grès "*supérieurs aux lignites.*" The Lignites themselves rest in the neighbourhood of Paris on mottled clay, absolutely identical with that of our Reading beds, and are the undoubted equivalents of the Woolwich series, consisting of stiff bluish clay with blackish bands and some fossil wood, exactly as in the Croydon cutting. Immediately on their eroded surface we find the calcareous Bracklesham beds with *Nummulites lævigata*, so that there is a hiatus in the Paris area represented in our series by the Oldhaven, London Clay, and Lower and Middle Bagshot.

We may place the Grès de Belleu anywhere in this interval, and the only reasonable conclusion to be drawn is that they do not belong to the Soissonnais series at all, but lie on it unconformably, or only apparently conformably on it, just as our Lower Bagshots lie on the London Clay at Alum Bay. In this case, while Prof. Prestwich's correlation of the "London sands" or marine so-called Lower Bagshot with the sands of Cuise-la-Motte and the Upper Ypresian is unaffected, the totally distinct fresh-water and true Lower Bagshot will also have its equivalent in the Paris Basin.

The suspected connection between the Floras of Alum Bay and Sheppey is strengthened by the flora of these *Grès*, for I have recognized quite a number of casts of fruits in them which are identical with Sheppey forms.

J. Starkie Gardner.

LARGE IRISH BOULDERS.

Sir,—In the Co. Galway, as mentioned in my Geology of Ireland, p. 248, also in the Geol. Survey Memoirs, the boulders are larger and more numerous than elsewhere in Ireland, much larger than any I have seen in the Co. Wicklow. The Ballagh Stone, a few miles N.W. of Galway, is about 21 × 24 × 20 feet. Clogh Currill is as large, and very like one of the ancient castles, while many others are much larger than the ordinary cabins of the country; they are all granite blocks. Huge limestone blocks once existed on the sandstone ridge near Ballingarry, Co. Limerick, but I am afraid that now they are all quarried away and burnt into lime (Geol. Survey Mem.). In the Co. Waterford Du Noyer drew attention to the huge conglomerate blocks, some of which he figured (Geol. Survey Mem.). The largest I saw was Clogh-na-Kilcluney, to the S.E. of the Comeragh Mts. One nearly as large is Clough-lowrish, figured by Du Noyer. In the Co. Wicklow, Wyley seemed to consider the largest to be that of Boleynass, near the Devil's Glen. Kath boulder, near the Bush Railway Station, Co. Louth, is 32 × 20 × 9 feet (Geol. Survey Mem.). In this district there are many whinstone blocks of large dimensions. S. W. of Ballina there are many erratics referred to years ago by Sir R. Griffith and Archdeacon Verschoyle. One granite block N.W. of Carrowmore has been calculated to exceed 415 tons in weight (Geol. Survey Mem.).

G. Henry Kinahan.

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THE METAMORPHIC ROCKS OF SOUTH DEVON.

Sir,—The writer of the letter printed in your January issue on this question (p. 46) does not seem quite to recognize the position which the microscope occupies in the investigation. As Professor Bonney in his previous letter to your journal kindly alluded to my work in the district under discussion, I may perhaps be allowed briefly to indicate the point, which, as it seems to me, is rather overlooked by Mr. Somervail. How he can have supposed Professor Bonney has anywhere stated that the microscope in geology is "everything" to the exclusion of field-work I cannot understand, for I remember more than one passage in which the opposite opinion is expressed.[1] The two modes of investigation are two independent witnesses, and the question is, can there be any value in a result founded on the one testimony alone, when an investigator, extremely well qualified to interrogate both, has come to an opposite conclusion? It is not even as if the two methods result in a complete contradiction. It is rather that the rocks at Hall Sands form one of those difficult cases where the unaided eye can scarcely be trusted. Here we find, almost in juxtaposition, a "schistified" fragmental rock and a "fragmentalised" schist. The question then is, can we draw a line of separation between the two? He who relies on field evidence alone may say, I cannot see it; but the worker with the microscope replies, There is a clear distinction. The positive statement, which is the result of employing the more delicate process of investigation, must surely be of the greater value; and in such case one could not rely on a hesitating or negative answer, which had been the only outcome of the more rough-and-ready method. But, in my opinion, even the field evidence is strongly in favour of the distinctness of the two series of rocks, when we take into consideration the sections, which occur elsewhere than at the coast of Hall Sands. The evidence of an abrupt change from a crystalline to a non-crystalline rock seems to me perfectly clear, not only at Hope Cove, but also along the estuary shores north of Salcombe and towards South Pool, and inland near Killington.

I was especially interested, in my first visit to the district, in the chlorite schist quarries near Hall Sands,[2] which are described in the article in the Devonshire Transactions; for this occurrence of chlorite schist completely disposes of any theory of progressive metamorphism. Certainly there can be no gradation from the slates of Hall Sands to chlorite schist. But I am puzzled by Mr. Somervail's statement that this chlorite rock reappears in the valley "on the north of Professor Bonney's junction, where according to his view it has no right to occur." The chlorite rock occurs to the south of the valley, and I do not understand on what grounds it is asserted to be north of the junction. Professor Bonney indicates the fault by a dash, which necessarily on a map of so small a scale,

[1] Geol. Mag. 1880, p. 299; and 1879, p. 203.

[2] In my map as published in the Quarterly Journal, two lines, which unfortunately escaped my notice, have been accidentlly introduced, making it look as if slate existed in the Bickerton quarry in contact with the schist. The quarry, as described by Mr. Somervail, is entirely of chlorite schist, with slickensided bands.

covers some inland country, but, as is clear from his description, he limits himself to the coast, and did not attempt to trace the faults inland, so that no arguments can be founded on the length or direction of this line, any more than on the breadth of the zone shaded to represent the occurrence of this or that rock in the cliffs. At Hall Sands the chlorite rock is not seen in situ along the shore, though it may exist beneath the sand on the south part of the beach. But I do not believe that it would occur, as seems to be suggested by Mr. Somervail, further to the north, because before that it would be cut out obliquely by the boundary fault.

To conclude:—as to the proof of a fault, I believe that if Mr. Somervail undertakes a microscopic investigation, after having gone through his intended course of study with that instrument, he will find that the strata are, as he demands, "thoroughly opposed to each other in mineral aspect." While the result of field-work is, that beds of chlorite-schist and of mica-schist strike up towards a certain boundary-line, and seem to be there cut off, which is surely suggestive of the existence of a fault.

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85, Hungerford Road, N.

MISCELLANEOUS

The New Professor of Geology at Oxford.

We are much pleased to announce that Mr. A. H. Green, M.A., F.R.S., F.G.S., has been elected to fill the office of Professor of Geology in the University of Oxford, a post rendered vacant by the retirement of Prof. Prestwich. Mr. Green, who is a Cambridge man, was Sixth Wrangler in 1855, and was subsequently a Fellow of Caius College. In 1861 Mr. Green was appointed an Assistant Geologist on the Geological Survey of Great Britain, and in 1867 he was promoted to the rank of Geologist; during his service he surveyed considerable areas of the Jurassic and Cretaceous rocks in the Midland counties, and of the Carboniferous rocks in Derbyshire, Yorkshire, and other northern counties. Many Survey Memoirs have been written wholly or in part by Mr. Green, among which we may mention the Geology of Banbury (1864), and the geological descriptions of the country around Stockport (1866), Tadcaster (1870), Dewsbury (1871), Barnsley (1878), and Wakefield (1879). The memoir on the Geology of North Derbyshire, of which the first edition was published in 1869, was written chiefly by Mr. Green, and the second edition, published last year, contains additions by him. His most important Survey work is the Geology of the Yorkshire Coal-field (1878).

In 1874 Mr. Green was appointed Professor of Geology in the Yorkshire College at Leeds, and while he completed some official Survey work after that date, he also published in 1876 a Manual of Physical Geology, a work which has taken a leading place as a text-book for students and teachers on this branch of the science; a third edition was issued in 1882. We may mention that for several years Mr. Green held the Lectureship on Geology at the School of Military Engineering at Chatham; until the authorities at